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CITY COUNTY STATE

FEBRUARY, 1923

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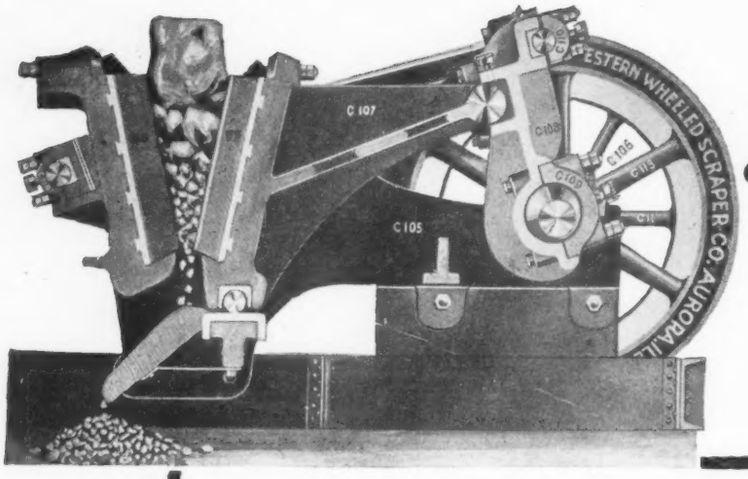

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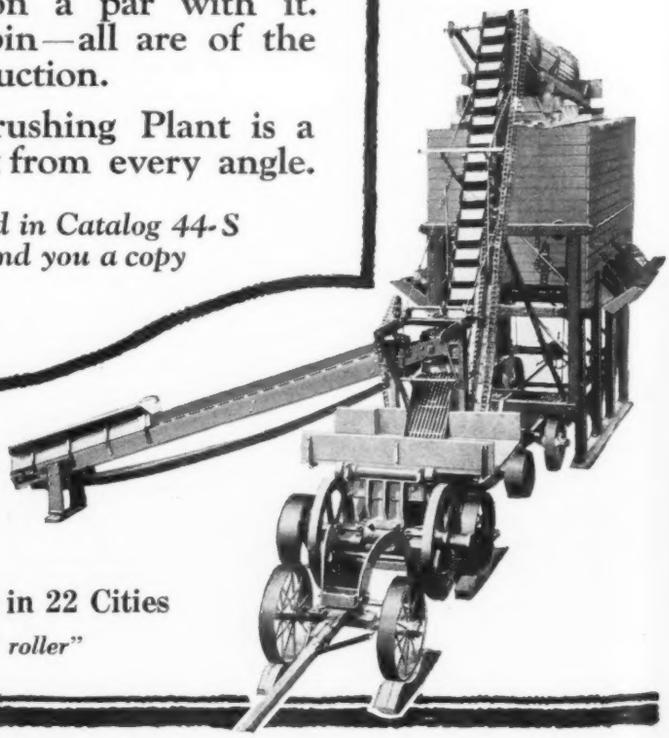

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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 February, 1923 No. 2

Municipal Pavement Repairing in Newark

Modern plant built in 1921 turns out asphalt binder and surface at about half the cost by an old plant requiring more hand work. Description of the new plant.

By James W. Costello *

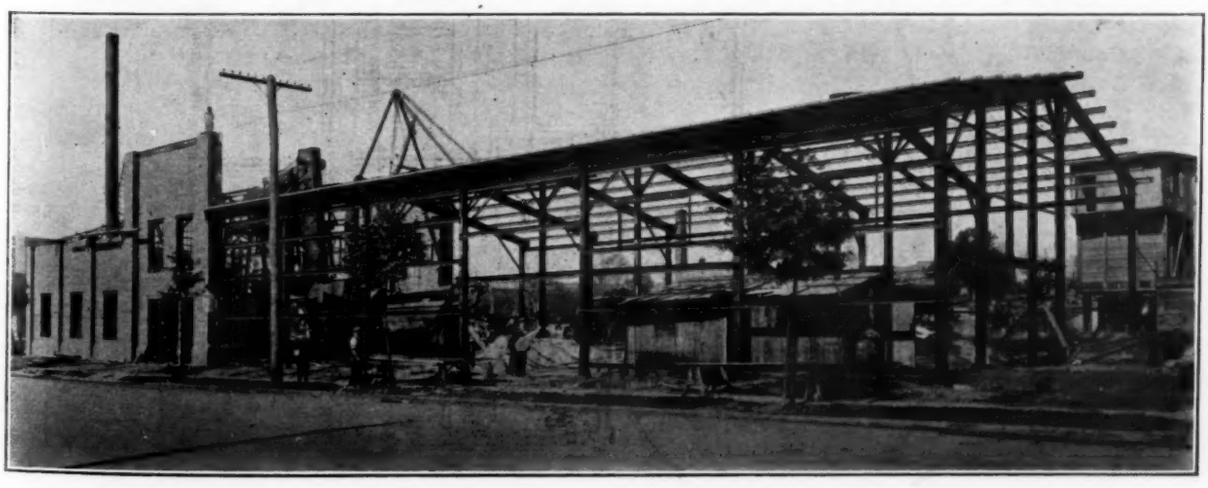
Previous to the fall of 1913 all repairs to asphalt pavements in the city of Newark, N. J., were made by means of the contract system, i. e., the city contracted for repairs to its asphalt streets for a stated price per square yard of repairs made. The city at that time had approximately 1,254,000 square yards of bituminous pavements to maintain. The contract price for repairs during 1913 was $1.18 per square yard. In 1912, the last full year of such repairs, 54,541 square yards of repairs were made at a cost to the city of $1.17 per square yard.

During 1913 the city erected a municipally-owned asphalt repair plant with a rated capacity in eight hours of 1,000 square yards of wearing surface 2 inches thick after compression. The plant was the portable, drum mixing type, Warren Brothers manufacture, set up as a stationary plant. This outfit took care of our requirements for eight years.

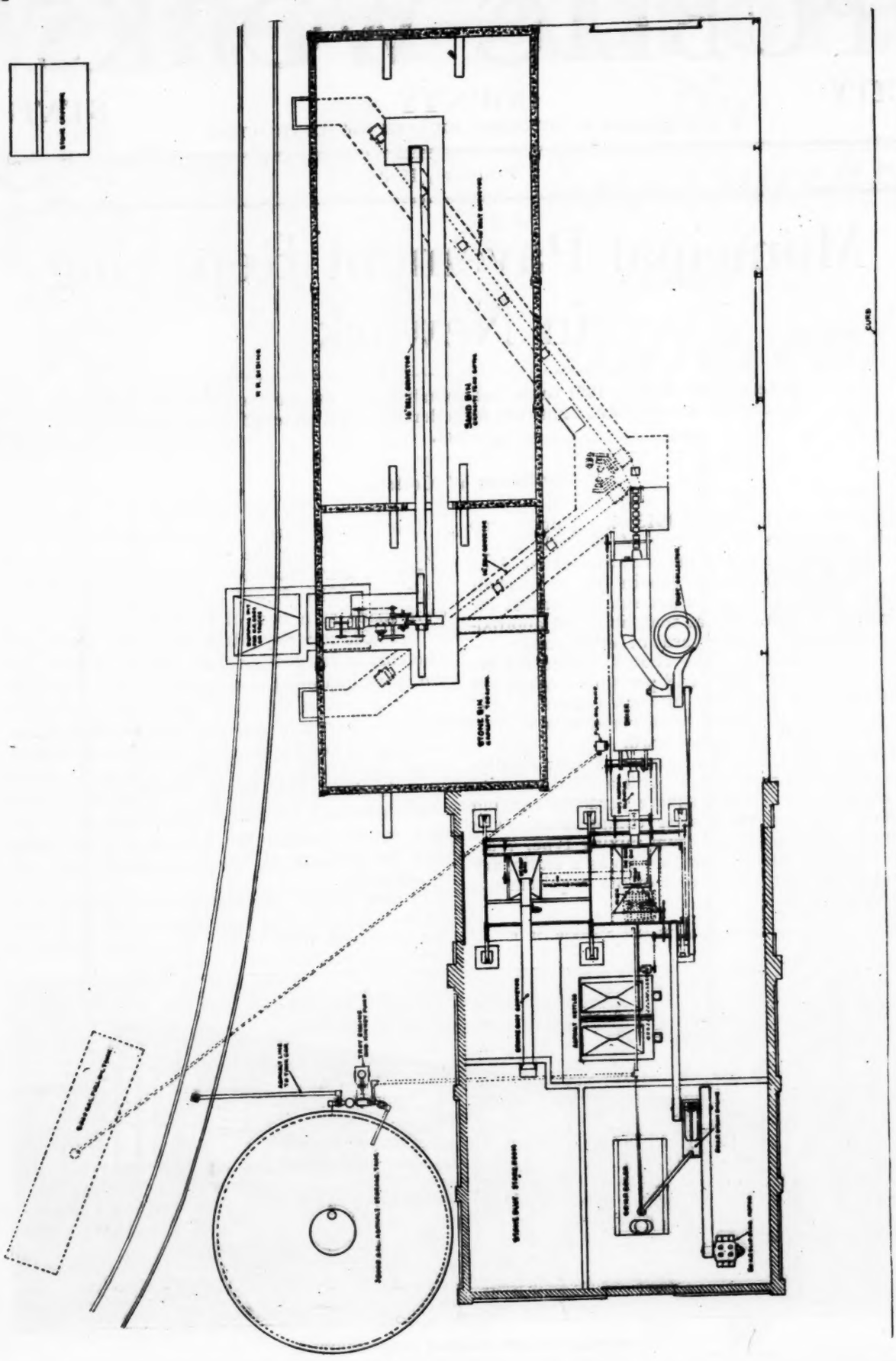
*Chief Engineer, Division of Works, Newark, N. J.

The first full year of our own repairs was during 1914. During the year 33,677 square yards of repairs were made at a cost of $1.29 per square yard. In 1915, 37,458 square yards of repairs were made at a cost of $1.10 per square yard; 1916, 51,606 square yards at $1.03 per square yard. The cost of repairs per square yard the first year the municipal plant was in operation was greater than the cost of the same work under contract, but as is seen this unit cost decreased in subsequent years and became less than the contractors' price. This high cost the first year of municipal operation is attributed to the inexperience of most of the men and crudeness of methods which afterwards were improved. It is also significant that the yardage of repairs required decreased considerably.

In making our own repairs, much better service has been obtained than by contract. The contractors made their repairs at certain periods of



ASPHALT PLANT DURING CONSTRUCTION



PLAN OF MUNICIPAL ASPHALT PLANT OF NEWARK, N. J.

the year and did not maintain a repair gang at work for the city the year round. This always tended to increase the amount of repairs needed, as holes and depressions were not taken care of as promptly as is now done with our own organization, which is busy continuously throughout the whole working season and makes such repairs as are needed, thus preventing the formation of a large hole or depression from a small one before attention is given same. Furthermore, there was always present a tendency on the part of the contractor to extend the "cutting out" beyond the point necessary to repair a hole and the taking out of depressions that did not really require attention.

The need for a larger and better plant had been recognized by the department for some time. The repair bureau does considerable new work, resurfacing of telford streets, new asphalt pavements, work for outside parties, etc. We found, as more of this work was being done by the department, an ever increasing need for a more modern plant of increased capacity.

The need for a new and modern plant and the advisability of extending the operations of our asphalt organization was recognized by Director Thomas L. Raymond, of the Department of Streets and Public Improvements, and he allowed the appropriation necessary to erect and equip the plant described below. The plans were made in 1920, the actual construction taking place during 1921.

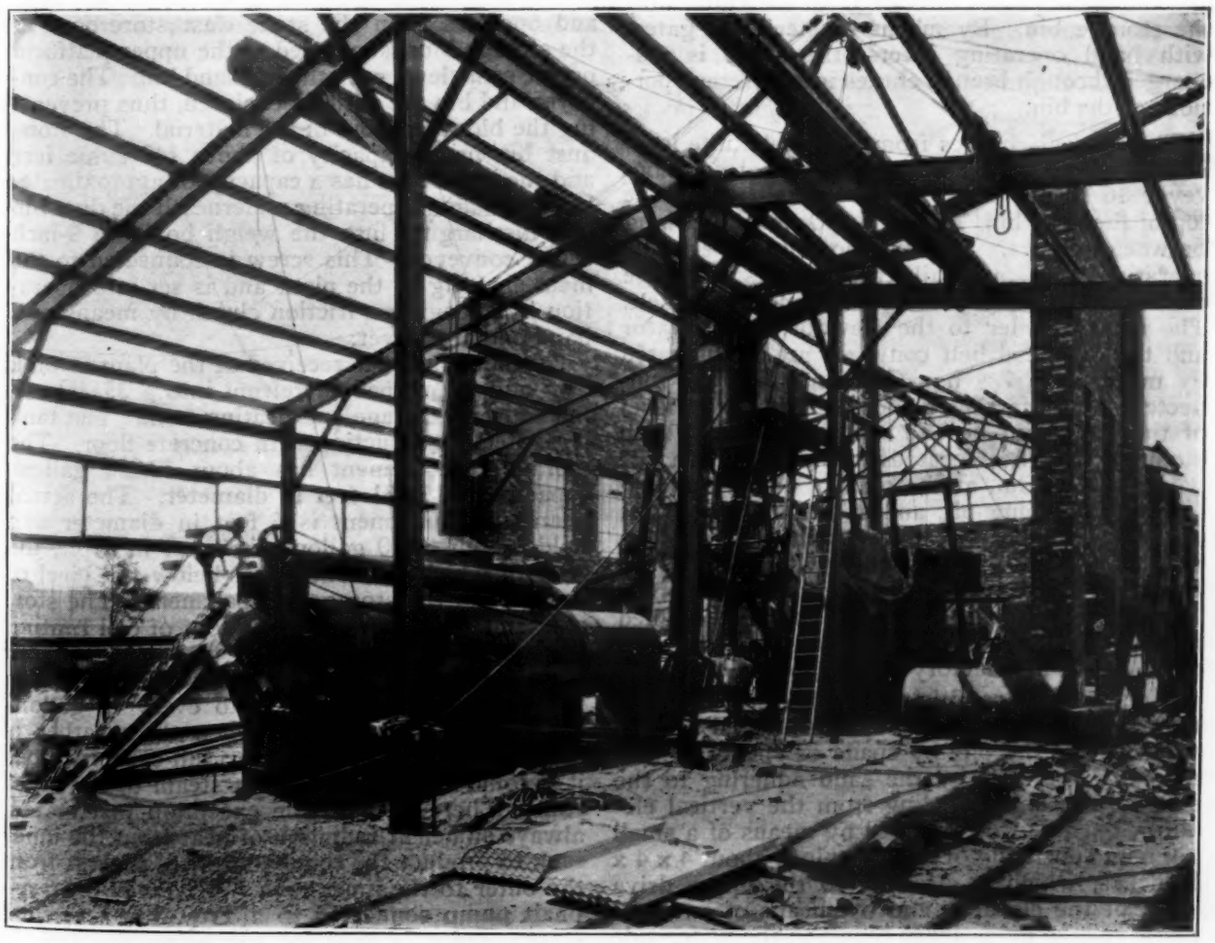
George W. Andress, principal assistant engineer, Division of Works, who has charge of the Bureau of Street Repairs, was placed in charge of the general layout, design and construction work required. The plant has been in operation during all of 1922.

THE NEW PLANT

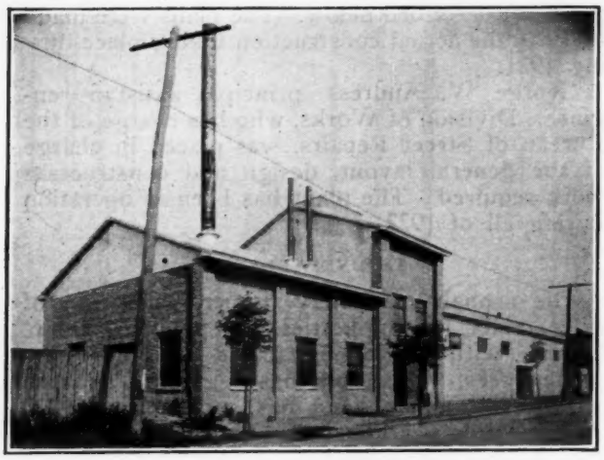
The asphalt machinery proper, consisting of drier, mixer, heating kettles, 60 h.p. boiler, 50 h.p. engine, with supporting tower and other appurtenances, was purchased from Warren Brothers Company, and has a capacity of 200 square yards per hour of two-inch wearing surface, after compression.

Additional features of the plant are a brick and steel building covering same, reinforced concrete storage bins for sand and stone, conveyors for handling sand, stone and limestone dust, asphalt storage tank with appurtenances, a 50 h.p. electric motor, an electrical pyrometer, etc.

The building covering the plant is of brick and steel construction, with corrugated iron roofing supported by steel roof trusses. Part of one end and one side is of corrugated iron, while one-half of the portion constructed of steel is enclosed by



NEWARK'S MUNICIPAL ASPHALT PLANT DURING CONSTRUCTION



STREET SIDE, MUNICIPAL ASPHALT PLANT

vertical reinforced concrete slabs between the columns, making the sand and stone storage bins.

We have provision for delivery of sand and stone by rail or motor truck. The material is dumped from either car or truck into a receiving pit from which it is fed by gravity through a rotary feeder into a 48-foot center, continuous, vertical bucket elevator. From this elevator the material is discharged into a steel enclosed chute and the stone passes directly from the chute into the storage bin. By means of steel flap gates, with hand operating levers, the stone is discharged through branch chutes into different portions of the bin.

The sand discharges from the steel chute leading from the elevator into a horizontal belt conveyor 16 inches wide, which operates over the top of the sand bin. This conveyor is 60 feet long between centers. A hand movable, steel plow operating on a small rail track permits discharge of the sand at any point desired along the belt. The rotary feeder to the elevator, the elevator and the overhead belt conveyor are all operated by means of a 7½ h.p. G. E. motor, gear connected, with starting devices on the floor level of the plant and on the switchboard, and with stopping switches located at the motor on the working platform, at the outside of the building near the dumping pit, and at the starting point on the switchboard. These switches enable a workman to stop the machinery, in case of an emergency, at any one of three different points. The conveyors, elevator and belt, are designed to deliver fifty tons of matrial an hour and will do so under satisfactory working conditions.

Moist asphalt sand is one of the most sluggish materials there is to handle; it will stand vertical when cut in the pile by spade or shovel. Some difficulty was met by the sand adhering to the sides of the chute leading from the vertical elevator, but this was obviated by means of a small hammer consisting of a maple block about 4 x 4 x 8 inches, which is attached to the upper drive shaft of the elevator, and by means of an automatic release gives sharp blows to the under side of the chute, at the rate of about eight per minute. The shock is slight but sufficient to prevent the clogging of the chute.

The materials are delivered from the storage bins to the drier by means of two reclaiming conveyors, operating in tunnels underneath the bins, receiving power from a 5 h.p. G. E. motor, gear-connected, with clutches so that either one or both may be run at a time.

Under the sand bin there is a belt conveyor 16 inches wide and 54 feet long between centers, and underneath the stone bin there is a similar conveyor 39 feet centers. There are four openings, 12 x 12 inches, through the roof of the tunnel underneath the stone bin, and five openings underneath the sand bin, the under sides of which are provided with adjustable gates. In running stone for binder, we find it requires the presence of only one man, who is in the tunnel, to deliver the stone from the storage bin to the drier; he merely opens the gate to discharge the required amount, which is conveyed by the belt to the cold material elevator pit, from where it is picked up by the elevator and delivered to the drier. The operation of the sand reclaiming conveyor is similar to that of the stone, except that we find the moist sand is hard to regulate in quantity at the gate, and we therefore have workmen (two at the most) feed the sand to the conveyor from the floor level of the bin with hoes or shovels.

The stone dust conveyor is of the bucket type and operates from the stone dust storeroom to the storage bins, supported at the upper platform on the same level with the hot sand bin. The conveyor and bin are entirely enclosed, thus preventing the blowing about of the material. The stone dust bin has a capacity of about 140 cubic feet and the storeroom has a capacity of approximately 4,000 bags. Operating underneath the dust bin and discharging into the weigh box is a 9-inch screw conveyor. This screw is connected to the main shafting of the plant and is set into operation by engaging a friction clutch by means of a hand-operated lever.

Asphalt cement is received at the plant in tank cars and is pumped therefrom into a 35,000-gallon capacity storage and heating tank. The tank is of steel construction with concrete floor. The storage compartment has about 32,000 gallons capacity and is 31 feet in diameter. The actual heating compartment is 6 feet in diameter and holds about 3,000 gallons; it is set in a pit, the floor of which is about 4 feet below the level of the floor of the storage compartment. The storage tank contains one square foot of coil heating surface to every 200 gallons of asphalt cement and the heating compartment contains one square foot of coil heating surface to every 12 gallons of asphalt cement. Only when the weather is cold, or the plant is running to full capacity, does it become necessary to admit steam to the outer coils. There is, with the exception just stated, always sufficient radiation of heat from the inner tank to produce the required flow of asphalt from the outer to the inner tank. A Kinney 6-4-6 asphalt pump connected to a Troy 5 x 7 vertical steam engine is used for conveying the asphalt cement from tank cars to storage tank and from

heating tank to the plant melting kettles or weigh bucket direct.

The plant was originally operated by means of a 50-h.p. steam engine connected up to a 60-h.p. boiler. Rather than increase the boiler capacity to take care of the additional load necessitated by the asphalt tank, we purchased a 50-h.p. Westinghouse slip-ring motor with a 50 per cent. variable speed control to operate the asphalt plant, thus leaving the entire capacity of the boiler for asphalt heating and pumping, and to operate the oil burners. Eventually, we intend to install steam coils in the two 24,000-gallon melting tanks of the plant.

The electric motor drives to the flywheel of the steam engine, which originally was used to operate the plant, and by disconnecting the connecting rod of same a very good countershaft is obtained without extra expense. The steam engine is kept connected to the boiler and may be used to operate the plant should a breakdown of the motor make it necessary to do so.

The boiler, engine and motor are located in a power room separately enclosed from the rest of the plant. The drier is heated by fuel oil burners, the fuel oil being pumped from a 9,000-gallon buried steel storage tank.

The temperature of the sand as it leaves the drier is determined by a Brown electrical pyrometer, the indicator of which is placed at a location convenient to the sand bin and the oil burner operator.

The cost of plant and equipment was as follows:

Mixing plant and machinery	$26,000
Building	19,670
Conveying system for sand and stone	15,250
Storage bins for sand and stone	8,380
Asphalt heating and storage tank	4,150
50-h.p. electric motor	1,860
Conveying system for stone dust and appurtenances	3,000
Incidental costs	1,690
Total cost	$80,000

COMPARISON OF PLANTS

A comparison of the costs of handling materials by the improved methods of our new plant with the costs of doing the same work with our old plant, where practically everything was by hand labor alone, is very interesting. By reason of our large sand storage capacity, whereby we can purchase sand in scow load lots instead of smaller quantities as heretofore, we effect a saving of about 15 cents per cubic yard, this being the amount the dealer saves by eliminating yard storage. The cost of conveying sand from storage to the drier in our new plant is about 20 cents per cubic yard as compared with about 34 cents per cubic yard for the same work in the old plant. Our contract price of asphalt cement during 1922 (purchased from the Texas Company) was $11.08 per ton less, delivered in tank cars, than it was during 1921 delivered in barrels; or the cost was $16 per ton placed in the heating kettles during 1922, as compared with $34 per ton placed in the heating kettles during 1921; the saving being produced by the reduced cost of A. C. in bulk shipments, and the mechanical handling.

In running stone for binder the cost is about 60 per cent. less than the cost of the same work when running binder with the old plant. Greatly reduced costs are had also in the handling of limestone dust, the exact figures not being available at present. The actual costs of production in our new plant when running somewhat below capacity, figured over a period when operating on contract work, were $3.65 per ton for binder and $4.88 per ton for top, the figures including only labor, material and supervision. We believe we can better these figures this year.

ORGANIZATION AND OPERATION

The asphalt plant organization consists of one superintendent, a stock clerk, an engineer, two plant men and five to ten laborers depending upon the extent of operations. As a comparison, the organization of our old plant when running to capacity consisted of one superintendent, one stock clerk, two plant men and eleven laborers, with an output of about 100 square yards per hour of 2-inch wearing surface after compression. When men are not needed in the operation of plant or handling materials we place them at the stone crusher, where we convert into crushed stone, old granite blocks, bridge stones and other old material suitable for crushing which cannot be used elsewhere, received from streets undergoing improvement.

In all our strictly new work we obtain contracts after bidding in competition with outside firms. The department enters into a contract with the city the same as though it were an outside party and is bound by the same conditions, and its work is inspected by the same construction bureau. We have during the past year made several thousand dollars, which is turned back into the repair fund for general street maintenance. Our work is conceded to be of first class quality and we have no trouble competing with contractors. We feel also that the competition which we create tends materially to reduce the costs of bituminous pavement work in this city, and we have received considerable favorable comment through the press and elsewhere for our activities.

It is expected that by the expansion of the work of the department along this line the bureau of repairs will become partially self-sustaining, and the asphalt plant prove to be a very profitable investment.

NOTE: The annual report for 1921 gives the following cost of repairs by city plant to pavements out of guarantee:

Kind of Pavement	Surface Layer Sq.Yds.	Surface Layer Per Sq.Yd.	Concrete Base Sq.Yds.	Concrete Base Per Sq.Yd.
Sheet asphalt	51,499	$1.8126	3,979	$2.3313
Granite block	27,815	1.5262	1,131	2.6651
Brick	6,679	3.4968	3,236	4.1820
Asphalt block	126	4.2169	59	2.9908
Wood block	4,168	4.4164	3,487	1.5341*

*Replacing 1 inch mortor cushion on existing concrete base.

Concrete Mixers and Mixing

By F. S. Besson *

Brief treatise on mixers, their classification, power, traction, distribution system, and method of use.

Mixer Types and Costs. The designs of mixers made by different manufacturers vary greatly, but any of the half dozen or more standard makes advertised in the engineering periodicals are satisfactory. While it is well known that there are three kinds of mixers—batch, continuous and gravity—the batch mixer is used for pavements practically to the exclusion of the others. Batch mixer outfits are divided into two classes known respectively as "S" and "E." The "S" class, having side loading and side discharge and no self-traction, are usually confined to general construction work, while paving mixers belong to the "E" class, generally having self-propelled traction with end loading and end discharge. Practically every construction mixer is furnished either on trucks or on skids, there being no difference in the machine itself, but in the equipment furnished with it. Data pertaining to the two classes of mixers, "S" and "E," are given in the accompanying table:

Data Pertaining to Class S and Class E Mixers

		Class S						
		Mixer on Skids		On Trucks with Power No Traction No Charging Skip			Class E Paver	
Size of Mixer	Horse Power	Weight Lbs.	Height Feet	Weight Lbs.	Length Feet	Width Feet	Weight Lbs.	Width Feet
3	1½-2½	500 to 1,000	3 to 4	1,000 to 1,500	5 to 6	4	....	.. ..
4	3-4	800 to 1,500	3 to 4	1,500 to 2,000	6 to 8	5	....	.. ..
7	5-7	1,500 to 3,000	4 to 5	3,000 to 4,500	8 to 10	6 to 7	7,000 to 8,000	6 to 7
10	8-10	2,500 to 4,000	5 to 6	5,000 to 6,000	9 to 11	6 to 7	14,000 to 18,000	7 to 8
14	8-14	4,000 to 6,000	6 to 7	7,000 to 9,000	11 to 12	6 to 7	18,000 to 22,000	8 to 9
21	12-18	6,000 to 8,000	7 to 8	9,000 to 12,000	12 to 13	6 to 7	20,000 to 26,000	9 to 10
28	18-25	7,000 to 9,000	8 to 10	12,000 to 14,000	13 to 15	7 to 8	30,000 to 35,000	10 to 11
56	35-45	14,000 to 16,000	9 to 12	....	.. ..	.. ..	....	.. ..
112	80-100	40,000 to 55,000	15 to 20	....	.. ..	.. ..	....	.. ..

Note: Horse power figures apply to electric or steam. A gasoline engine should be provided with a large excess of power in order to allow for dirty spark plugs, too much oil, worn pistons, etc.

The tabulated weights indicate in a general way that some machines are of more rugged construction than others, and accordingly, they stand up better under heavy work. To obtain a rough approximation of the cost (1922) of the different sizes from the smallest mixer to the largest, a cost of from 20 to 25 cents per pound may be assumed, to which must be added for delivery 2 or 3 dollars per hundred pounds, or whatever the freight charge may be. Generally, the smaller machines cost less per pound than the larger and more efficient ones. In choosing a mixer, its first cost is not of most importance—operating and maintenance costs must be considered:—in fact, requirements for profitable mixer service are, in order of importance, (1) endurance; (2) speed of operation; (3) mechanical simplicity; (4) operating simplicity; (5) service in purchase of repair parts, and (6) first cost.

Class "S" Mixers. Class "S" mixers on skids are illustrated in Figs. 1 and 2. Practically all manufacturers turn out class "S" mixers for skid mounting. They are on the market from the smallest size, No. 3-S, to the largest, No. 112-S. Power and secondary equipment and attachments for use with the mixer can be obtained with it, but often mixers on skids are bought alone and fitted into existing plants, whether the power be gasoline, steam or electric.

Mixers on trucks are illustrated in Figs. 3 and 4. Generally, manufacturers mount all styles of their mixers on trucks, except in the very largest sizes. The type shown in Fig. 1, when mounted on trucks, is popular for small work. It may be noticed that the batch is both fed into and discharged from the one drum opening. Small mixers such as this are generally operated by gasoline motors, and though of comparatively light weight they are well worth their cost. For heavier types of mixers there are two methods of discharging. Some receive the charge into the drum at one end and the drum is tilted in order to discharge from the other end, an example being the mixer illustrated in Fig. 2. Other mixers have drums that do not tilt, but discharging is accomplished as illustrated in Fig. 3, by means of a discharge chute, which is thrown into or out of the drum opening.

It is not uncommon to find the mistake being made of using a class "S" mixer where class "E" should be used. For some work, as for instance in a narrow alley, the side-discharge truck mixer is very unhandy, and in such cases it is found that barrow men, at much expense, wheel aggregate long distances to the mixer and concrete long distances from it. Some small mixers, especially of that type shown in Fig. 1, are

*Major, Corps of Engineers, U. S. Army, Assistant to the Engineer Commissioner of the District of Columbia.

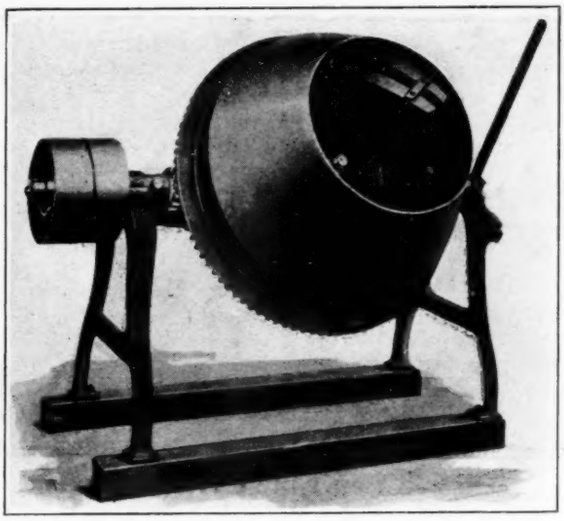


FIG. 1—AN ECONOMICAL TYPE OF MIXER FOR SMALL WORK, USUALLY LIMITED TO NO. 7 SIZE OR SMALLER. CAN ALSO BE OBTAINED MOUNTED ON TRUCKS AND WITH LOADING SKIP

mounted so that they can be rotated on the trucks and discharge either to the side or to the end, thus combining in one machine both class "S" and class "E" principles.

Class "E" Mixers. Class "E" mixers are designed primarily for paving work. An example is illustrated in Fig. 5. Some manufacturers are confining their pavers to three sizes, Nos. 10-E, 14-E, and 21-E. Others make also, sizes 7-E and 28-E. No. 21-E is the largest that is economical for ordinary work. It mixes concrete about as fast as the best of organizations can deliver materials and handle the concrete as discharged. The No. 28 size is suitable only for extraordinary paving projects; for example, such as have been contracted for recently by one or two states.

Power. For portable types of mixers generally either gas engines or steam are used. Electric motors are often used for stationary mixers. Gas engines are invariably of higher rated horsepower for each size of mixer than either steam or electric. Several years ago steam was greatly favored for large pavers. Lately high-grade, reliable, and economical gasoline units have been perfected for pavers and are now a popular choice. Steam is objectionable in cases where conditions relative to the employment of steam engineers and firemen are so unreasonable as to make operation costs excessive. If a gas engine is used for a large mixer it should be of four cylinders and have plenty of excess power. Good service will then be rendered, and that which is not always true for steam, no trouble will be had in obtaining mechanics to operate the engine. The choice of a gas engine, of course, does away with the trouble of handling heavy fuel, getting up steam, firing the boilers, cleaning boilers, etc.

Traction. Multiple tread traction as illustrated in Fig. 5 handles better on the job and does not sink into soft ground as readily as do wheels, though the latter give swifter movement from job to job, which is an important element in city work because generally a season's work is made up of a large number of small items widely distributed throughout the city. Even with wheels, however, paver speeds generally are less than 1½ miles per hour. If hauled as a trailer behind a truck at greater speeds, the machine is unduly shaken and jolted. This can be corrected by mounting the mixer on a truck equipped with rubber tires and motor vehicle bearings. If a trailer is made with motor truck wheels and bearings and a chassis that can be tipped, so that a paver can crawl aboard by its own power and be hauled as illustrated in Fig. 6, then much time can be saved, wear and tear greatly reduced and multiple tread traction used to the best possible advantage.

Boom and Bucket. Now that the use of relatively dry concrete is firmly established, boom and bucket distribution is becoming more commonly used, though a chute is cheaper in first cost and cheaper in maintenance. Depending upon the size of the machines, booms range from 15 to 20 feet in length. With some mixers cer-

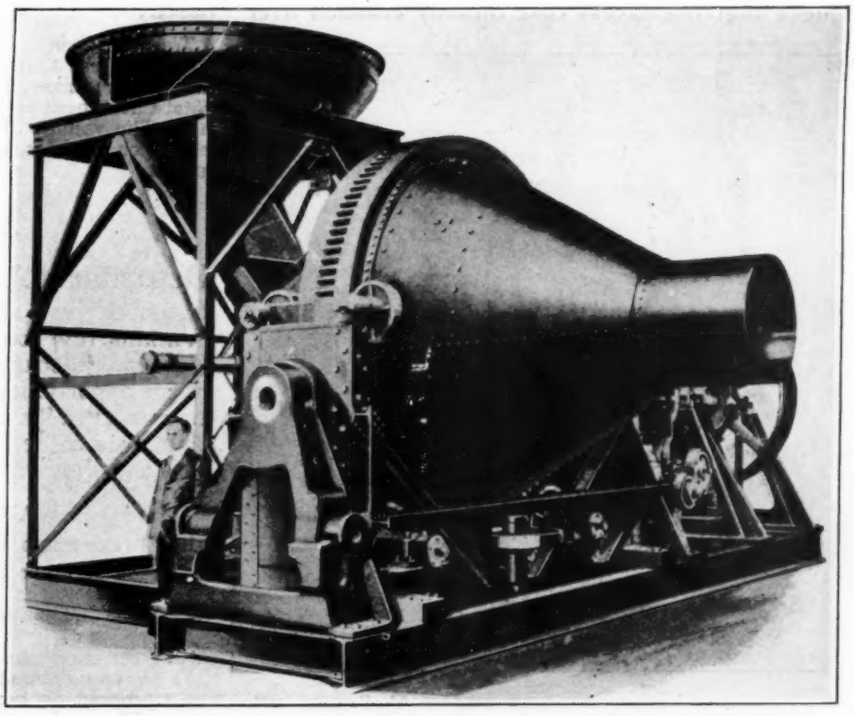


FIG. 2—A HEAVY TYPE OF MACHINE, OBTAINABLE UP TO AND INCLUDING THE NO. 112 S SIZE

tain faults have been noticed. A purchaser should be sure that the boom can be swung when out of horizontal when working up or down hill, that the bucket is full-batch capacity, and that it can be handled for the full length of the boom without overbalancing the machine. Deficiencies as to these points probably have been corrected in all recent mixer models.

Water. The importance of maintaining the proper consistency being apparent, the necessity of having a measuring gauge regulating the amount of water for each batch is readily realized. The necessity of taking care of such variable factors as rain-soaked or sun-dried aggregates must, however, be recognized and the water lock required by the Joint Committee's specifications should not be made such a permanent fixture as to make it difficult to compensate for these variables.

In addition to the provisions as to measuring water, the Joint Committee proposed:

Water. Water for concrete shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substance.

Time of Mixing. The time of mixing is an important element, and as it largely controls the output of the mixer, and therefore the cost of the concrete, it needs careful consideration. Tests with various batch mixers at present on the market show a rapid increase in strength for the first minute concrete is mixed, and a smaller increase for the second minute, after which the increase continues smaller as the time of mixing increases. The increase in strength appears whether the concrete is tested at 7 days or after the lapse of considerable time. While some engineers now specify a 1½ minute mix, the great majority of contractors appear to believe that the excess cost thereby entailed over

FIG. 3—A LIGHT-WEIGHT MIXER MOUNTED ON TRUCKS AND EQUIPPED WITH A TIMBER PLATFORM FOR DIRECT CHARGING FROM BARROWS

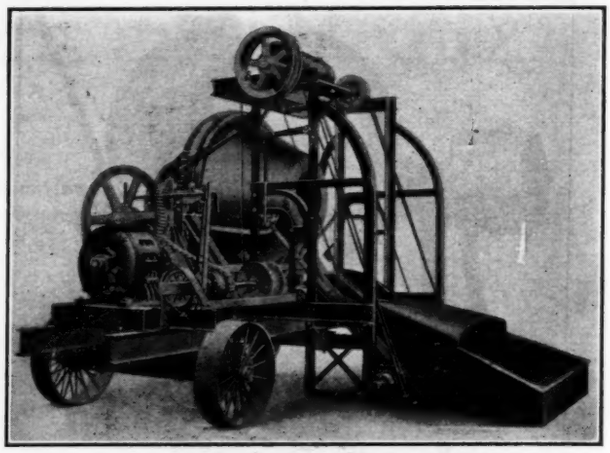


FIG. 4—A HEAVY-DUTY TYPE OF MIXER

that for a minute mix is not justified by the extra strength obtained. The addition of a little cement for extra strength should be given consideration in place of lengthening the time of mixing.

It may be that in the near future an improved mixer will be developed that will give full strength concrete in less than a minute. Such a machine would add much to the economy of mixing. There is now no question, however, as to fixing one minute as a minimum. If less time is specified, water is not worked through the mass as it should be, and in order to get this consistency, the mixer man may use more water than should be permitted. A batch meter to insure the full mixing time after all the ingredients, including the water, are in the drum, is absolutely necessary. The Joint Committee proposed:

Time of Mixing. The mixing of each batch shall continue not less than 1½ minutes after all the materials are in the mixer, during which time the mixer shall rotate at a peripheral speed of about 200 feet per minute. The volume of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer.

(*To be continued*)

Department Aid to Highway Contractors

A notice was sent out early in January by J. S. Watkins, division engineer of the Kentucky State Highway Department, notifying all contractors of an opportunity that would be furnished them to inspect in his company a road for which a contract was to be let on January 23d. The notice was as follows:

HIGHWAY DEPARTMENT NOTICE

To All Contractors:

Please be advised that on Wednesday, January 17, I will go over the Barbourville-Corbin road in Knox County, which is advertised for letting on January 23. Those of you who are interested in bidding on this project will meet me at the Jones Hotel in Barbourville, Ky., on the above mentioned date at 9 a. m., at which time we will proceed on horse-back or in hacks toward Corbin, Ky. The entire project should be thoroughly covered in five hours' time. I would appreciate it if those of

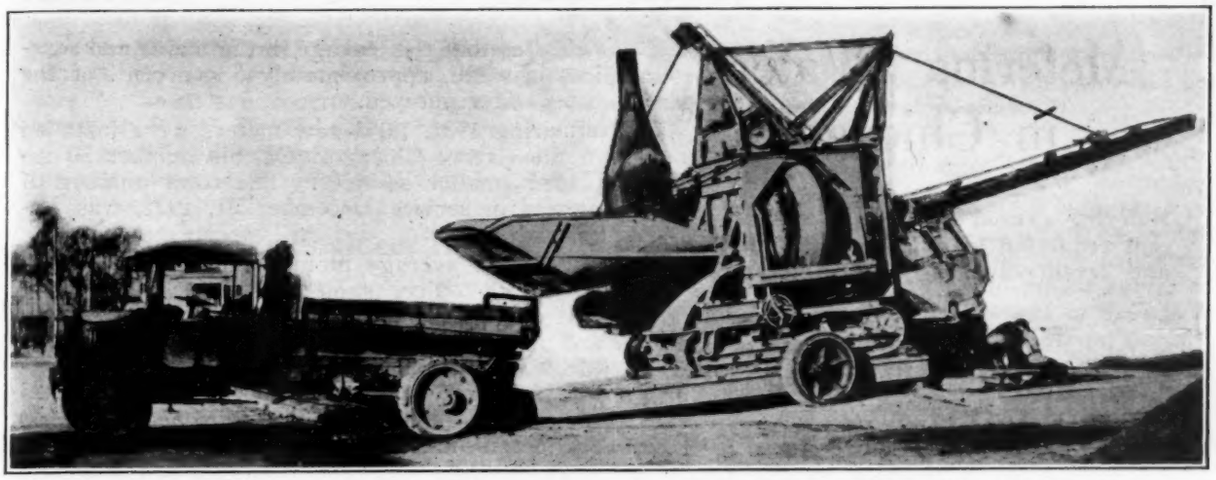


FIG. 6—A 21-E MIXER LOADED ON A LOW TRAILER FOR TRANSPORTATION FROM JOB TO JOB

you who will be present on this trip, will kindly notify this office by January 15 so that arrangements can be made for horses.

J. S. WATKINS, Div. Engineer.

Weight of Pavement Reinforcement

There is a wide variation in the specifications for reinforcement used in concrete pavements, the minimum weight being 25 lbs. per hundred square feet and the maximum 90 lbs. In New York State alone there are five different weights, namely, 25, 30, 40, 56 and 60 lbs. per hundred square feet. However, this year New York adopted 63 lbs. as standard. This information was given by W. C. Kuhn, of the American Steel and Wire Company, in a paper before the New Jersey Highway Association. In addition, he gave figures concerning a number of other states.

Pennsylvania calls for 56 lbs. per 100 square feet, which is increased from the former specifications of 25 lbs., and the state is considering still further increasing the standard to 65 lbs. In the south 25 lbs. was the usual specifications in the few cases where reinforcement was used. In the middle west the specifications vary from 30 lbs to 55 lbs.

In New Jersey from 34 to 56 lbs. have been specified for "single reinforcement" and a total of 90 lbs. for double. Forty-five lbs. was used in the Fort Lee Turnpike across the meadows because of the soft ground over which the road was constructed, and one section 3,500 ft. long has been down since 1917 and a second section 1,000 ft. long since 1919, and there are only one or two cracks in the entire road. Mr. Kuhn said that there is a tendency to increase the New Jersey County specifications to 56 lbs., but he does not see the logic of increasing the cost of the road to this amount since practically all county roads are in the secondary system and not subject to the heavy traffic of the state roads where the 56 lbs. reinforcement is used.

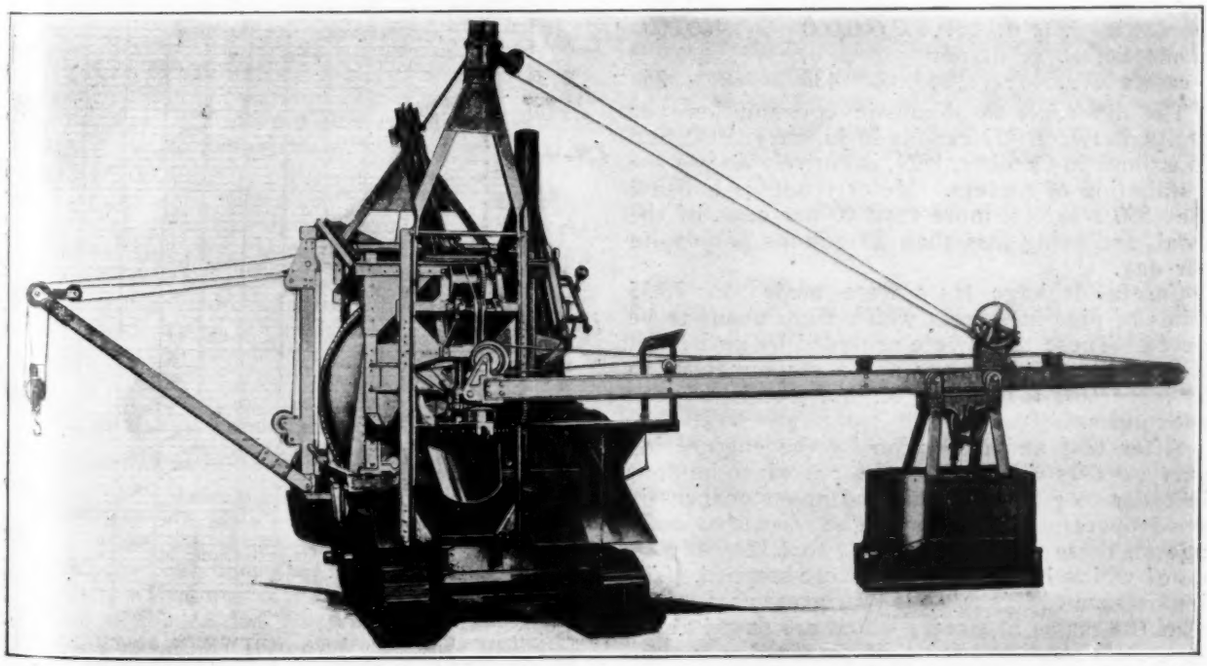


FIG 5—THE COMPLETE PAVER, WITH DERRICK FOR HOISTING BATCH BOXES TO THE CHARGING SKIP

Metering Water in Chicago

Metering caused more than eighty per cent reduction in domestic consumption and seventy-five per cent in total consumption.

The following paragraphs are found in the latest annual report of H. L. Lucas, superintendent of the Water Pipe Extension Division of the Chicago Department of Public Works:

During 1920 meters were installed on every service, about 850 in number, in the town of Hegewisch, with remarkable results in regard to reduction in consumption. A series of curves is attached to this report showing the effect of meter installation. A test made on Jan. 31, 1920 showed the total average consumption in Hegewisch amounting to 2,730,000 g. p. d. On Nov. 10, 1920, when the meters were about one-half installed, the total average consumption was 1,640,000 g. p. d. During 1921 these meters were read on different occasions and efforts made to stop the waste and reduce the loss due to leaky plumbing and the use of hopper closets, resulting in further reduction in this section. Final test made on Oct. 20, 1921 indicated an average daily consumption of 620,000 g. p. d., which is less than 25 per cent. of the original consumption. Following is an interesting comparison between the flows before and after the installation of meters.

	Jan. 1920	Oct. 1921
Total flow, g. p. d.	2,730,000	620,000
Industrial and Burnham, g. p. d.	130,000	160,000
Domestic, g. p. d.	2,600,000	460,000
Domestic, g. p. d., per capita	433	75

The difference in domestic consumption per capita, between 433 gallons in January, 1920, and 75 gallons in October, 1921, is entirely due to the installation of meters. Meter readings indicate that 530 services, more than 60 per cent. of the total, are using less than 23 gallons per capita per day.

Careful leakage tests were made on 78.55 miles of pipe in streets which were about to be paved. These tests were preceded by an inspection of the service pipes and a recommendation by inspectors for cutting off and abandoning unused pipes.

After test and inspection by the engineering party, orders were prepared for work to be done in order to put the mains and appurtenances in good operating condition. The measured leakage on these streets amounted to 1,124,190 g. p. d., of which 1,068,811 g. p. d were stopped. The importance of this work is very great as it meant that the mains in streets which are paved are in first class condition and that the leakage is eliminated. A table attached which shows the results of these tests over a period of the last five years indicates that the leakage in the mains and services is small, approximately 5 per cent. of the total water pumped.

During 1921, 1,043 new meters were installed in the city of Chicago. Of this number 70 replaced smaller services. The total number of meters in service December 31, 1921, was 30,757.

With an average monthly force of 46.9 employes in office, shop and field there were performed 36,749 jobs of repairs, replacements and installations of water meters at a cost of $18,882.59 for supervision and clerk hire; $86,350.36 for mechanics and laborers and $20,503.23 for cartage—a total of $125,736.18 and $55,362.40 for meters, meter parts and material.

The average cost per job of each of the several items was as follows:

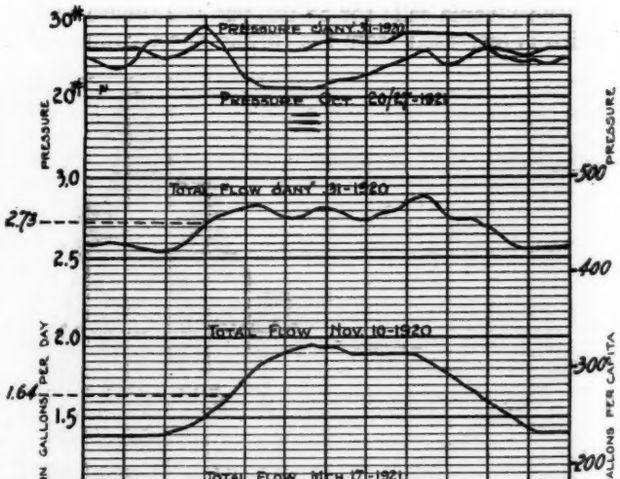
Field work—Investigations, $1.91; meters removed permanently, $2.40; meters repaired on premises, $2.42; meter locations changed, $3.31; meters replaced, $4.92; leaks repaired, $9.21.

Shop work—Meters tested before repairs, $0.65; meters tested and sealed after repairs, $0.53; meters repaired in shop, $5.77; meter parts rehabilitated, $.76; material rehabilitated, $2.58.

The above does not include supervision, clerk hire or maintenance of equipment, which averaged $.90 per item.

Pavement Cuts in Los Angeles

In Los Angeles a special force under the city engineer repairs all trenches cut in streets and charges the firm or person to whom the permit for the cut



CONSUMPTION IN AREA BETWEEN 127TH AND 138TH STREETS, AVENUE A AND YATES AVENUE. 18 acres in parks, 127 in factories, 67 in railroads; 833, total.

was issued at the rate of 40c per square foot for asphalt pavement or brick pavement, 30c per square foot for macadam, concrete pavement or granite block, 12c for oiled gravel and 1c for streets neither oiled, gravelled nor paved; also 28c per square foot for sidewalks and 50c per lineal foot for curb.

Water Works Engineer Honored

A storage dam in the Scioto River forming a part of the water works of Columbus, Ohio, has heretofore been known officially as the "Columbus Storage Dam," this name having been given it by council in 1905. On the 18th of last December council ordered the name of this dam changed to "The Julian Griggs Dam, in honor of Julian Griggs, who so faithfully and well served the city as chief engineer and who was one of the prime movers in the movement to construct said dam and who had general supervision of its construction."

It is not often that a city gives any recognition other than his more or less inadequate salary to the services of an engineer, no matter how profitable these may have been to the city, and this recognition of Mr. Griggs' service is very gratifying.

Philadelphia's Water Finances

The Chief of the Bureau of Water of Philadelphia, Carleton E. Davis, in his report for the year 1922, states that this was the most profitable in the history of the Bureau, the net revenue for the year being nearly $3,000,000. The total receipts were in excess of $6,450,000, which is one-quarter of a million greater than those for 1921. The gross yearly return from the works was more than ten per cent. of the city's entire income from all sources. Deducting the operating and maintenance expenses from the gross income leaves more than enough to carry the fixed charges on more than $40,000,000 of bonds, which is greater than the amount outstanding. Because of this the Court has permitted the exemption of the waterworks bonds from the calculation of the debt limit of the city.

In addition to this direct profit, the city also receives the free use of water furnished to every municipal activity, such as schools, swimming pools, fire protection, etc.; also 90 per cent. of the regular rates is deducted from bills to all charitable institutions, this discount amounting to nearly $150,000 a year.

Low Salaries for Public Officials

An unusual recognition of the fact that many of the technical employees of city, state and federal governments are underpaid is reported from New Jersey, where the State Board of Health in December adopted resolutions favoring the enactment of legislation which would provide a monthly pension for the widow of Dr. R. B. FitzRandolph, who had been assistant director of the State Board of Health for many years prior to his death. It was argued in favor of this that Dr. FitzRandolph had made financial sacrifices in remaining in state employ and that the remuneration paid him had been inadequate for the services rendered.

Municipal Gas Plants

The Census Bureau has recently published a report on "Manufactured Gas," the data being those collected in the year 1920 and applying to the year 1919. Comparison is made with similar figures for the year 1914, showing the changes in the gas industry during that comparatively short period.

These figures show that during this five-year period the number of establishments engaged in the commercial manufacture of gas delivered through mains decreased from 1,284 to 1,082 and the wage earners from 43,792 to 42,908. The product, however, increased in value from $220,238,000 in 1914 to $329,279,000 in 1919. In spite of the slight reduction in number of wage earners, the total wages paid was almost doubled, from $26,802,000 to $52,759,000.

One table was devoted exclusively to municipal establishments and showed that during this five-year period the total number in the United States had decreased from 138 to 57. Most of this decrease was in the east north central and west north central sections. In the New England, Middle Atlantic and Pacific sections the numbers remained the same, while in the South Atlantic section the number of establishments fell from 17 to 15, and in the East South Central from 3 to 2.

Comparing the two years, the number of establishments manufacturing straight coal gas and carbureted water gas remained the same; those manufacturing mixed coal and water gas increased from 3 to 6, while the number manufacturing oil gas decreased from 4 to 2, acetylene gas from 31 to 8 and gasoline (cold process) gas from 71 to 12. The value of the products in these municipal establishments, in spite of the decrease in number, increased from $1,757,017 to $2,778,069. Perhaps the most remarkable comparison is shown by the east north central district, where, although the number of establishments was reduced by about 70%, the value of the products was more than three times as great.

Toledo Garbage Disposal Bids

Toledo recently received bids for disposing of the city's garbage, which at present amounts to between twenty and twenty-three thousand tons per year. Three bids were received, one from the Pan-American Milling Company, which offered to accept the garbage from the city at its West Toledo plant, the city to pay $1.25 per ton and furnish water free to the plant, or $1.50 per ton, the company to pay for the water. The contract to be for ten years. The company proposes to make hog feed of the garbage. (This company last year was receiving about 42 tons a day from the city, which was paying $1.25 per ton and hauling the balance to the country where it was scattered on farms.)

The Indiana Salvage and Feeding Company propose to feed the garbage to hogs, the city to

deliver to a hog farm within a ten-mile radius and pay 75c per ton, or deliver to a farm within a 25-mile radius and pay 50c.

A third bid was submitted by F. C. Alber, who proposed to use the reduction method and turn the by-products over to the city, which would pay him $4.00 per ton of garbage received.

In addition to these three bids, the director of public service, William T. Jackson, has submitted a proposition for constructing four incinerators in different parts of the city, each to handle the garbage from its own district or zone. He believes that this would reduce the cost of collection, which is now more than $1.50 per ton because of the long haul. He estimates the cost of each incinerator plant at about $50,000.

These plans were presented to council early in January.

The costs of collecting and disposing of garbage were reported to have been $82,506 in 1919, $116,918 in 1920 and $141,805 in 1921.

Progress on Decatur Sewage Plant

Work was started late last summer on a sewage treatment plant for Decatur which, it is expected, will be completed early next fall. The sewage will first pass through Imhoff tanks, a dosing tank which will distribute the effluent over about three acres of sprinkling filters, and from these filters the effluent will pass to a Dorr secondary treatment tank 85 feet in diameter. Work on this tank is being carried on during the winter whenever the weather is favorable.

Activated Sludge for Pasadena

Plant to treat six million gallons a day, sludge to be dewatered by sulphur dioxide, drum screen and roller press. Sludge for fertilizer, effluent for irrigation.

For many years sewage treatment at Pasadena was interesting to sewerage engineers because Pasadena conducted one of the few financially successful systems of disposing of sewage by irrigation. The sewage was distributed on a farm of 517 acres and various crops raised, probably the most remunerative being English walnuts.

Recently the growth of population in the vicinity of the farm has caused dissatisfaction with this method of disposal and a substitute was sought for. Last year Pasadena, Alhambra and South Pasadena decided to unite in the construction of an activated sludge plant, this conclusion having been reached after the operation of an experimental plant. One argument in favor of the activated sludge method was the demand for fertilizer in the immediate vicinity.

The plant is designed to treat 6,000,000 gallons a day, although the present sewage flow is little more than half of this. The sewage will first pass through a coarse and then through a fine screen and from this to the aerating tanks of the activated sludge process. Material collected on the coarse screen will be buried and that intercepted by the fine screen will be carried directly to the dewatering plant.

There will be eighteen aerating tanks each 50 feet long, 9 feet wide and holding 15 feet depth of sewage. Each tank will contain 60 filtros plates 12 inches square set in cast iron plate holders previously dipped in hot asphaltum to prevent rust. The plates rest in the holders on felt gaskets and are cemented in place by asphalt poured around the edges, while iron rims bolted to the plate holders by brass bolts will hold the plates in place. Each plate holder will be supplied with air through a 1-inch galvanized pipe. The bottom of the tank is constructed in the form of pyramids between the plates so that no sediment can settle on the bottom and putrefy. It is proposed to supply one cubic foot of air per gallon of sewage and to retain sewage in the aerating tank for four hours.

There will be eighteen sedimentation tanks, each 22 feet long, 9 feet wide on top and holding 27 feet of water in the middle, the bottom being hopper shaped with sides sloping at an angle of 60 degrees, each hopper terminating in a 4-inch discharge pipe. The effluent will discharge over a weir extending the entire length of each side. The effluent from the aeration tanks will enter the sedimentation tanks through adjustable slots three feet below the surface. The sludge pipes from the bottoms of the hoppers rise to within 1 foot of the water surface and there terminate in an elbow, in the outer end of which is an 18-inch nipple, the elbow being loose so that the nipple can be turned into any position from vertically up to vertically down. This construction permits drawing off the sludge at any desired rate up to the full capacity of the 4-inch pipe by simply revolving the elbow.

The sludge is discharged directly into re-aerating tanks 12½ feet long by 7 feet wide and 15 feet depth of liquid, the filtros plates being arranged as in the primary aerating tanks. From the re-aerating tanks any desired quantity of sludge may be returned by means of an air lift to the primary tanks, while decanting devices similar to those in the sedimentation tanks permit the removal at will of sludge to be dewatered.

It is planned to dewater the sludge by the recently developed process of using sulphur dioxide, cylindrical drum screen and roller press, as tested last year at Houston and described in PUBLIC WORKS recently. The sludge with a moisture content reduced to 75% will probably be sun-dried during the summer months and placed on the city farm as fertilizer during the winter. That sun-dried in the summer to about 10% moisture will possibly be passed through pulverizing rolls and sold to orange growers for fertilizer.

The effluent from the sedimentation tanks will be discharge into a ravine or raised by centrifugal pumps for irrigating the municipal farm. That wasted into the ravine will pass over a bluff where a fall of 20 feet over a series of cascades will additionally aerate it.

The air required for aeration will be supplied by electrically driven hydro-turbine blowers capable of

delivering air at a pressure of 10 lbs. At the plant will be constructed a chemical laboratory and an office for the superintendent in one building, a tool house and garage in a second, and the necessary machinery will be housed in a third.

Milwaukee Refuse Destructor Report

Description by City Engineer Staal of incinerator plant at Montevideo and result obtained by it.

Several months ago the city engineer of Milwaukee, George F. Staal, examined a refuse destructor in operation at Montevideo, Uruguay, and has reported upon the same to the Common Council of his city, with a view to aiding it in its study of methods and appliances for refuse disposal suitable for supplementing the refuse destructor plant of Milwaukee which has almost reached the limit of its capacity. The following is abstracted from Mr. Staal's report:

Montevideo has a population of about 400,000. It is distinguished by its superb system of boulevards and parks, surpassed by few if any of North America. It is all the more notable, therefore, that the refuse disposal plant of the city is located only seven blocks from the municipal building and on the new Boulevard Wilson, in a residential district. A committee of prominent engineers and sanitarians of Uruguay in 1914 reported, recommending high temperature incineration for disposing of the refuse of that city and a plant on the Balmer system, several of which were already in operation in Buenos Aires.

The plant comprises three batteries of furnaces, each battery containing three fire grates 6 ft. x 7 ft. under a common crown. The furnace doors are cast in two sections which are air jacketed, hang on rollers and have a free lateral movement in either direction. Each battery has its own forced draft unit consisting of a Sirocco fan blower and a G.E.C. motor of 15 h.p. The supply of air to each ash pit is controlled by a simple slide valve. The ash pit doors fit with a tight gravity seal.

Each battery has three mechanical feed hoppers, the discharge of which to the furnace is controlled by the fireman by means of a hand wheel at the side of the corresponding furnace door. The three batteries are connected by an overhead platform in which the mechanical feed hoppers are set. This platform, called the charging platform, runs the full length of the furnace room and on it work the men who draw the refuse from the storage bins and load it into the mechanical feed hoopers.

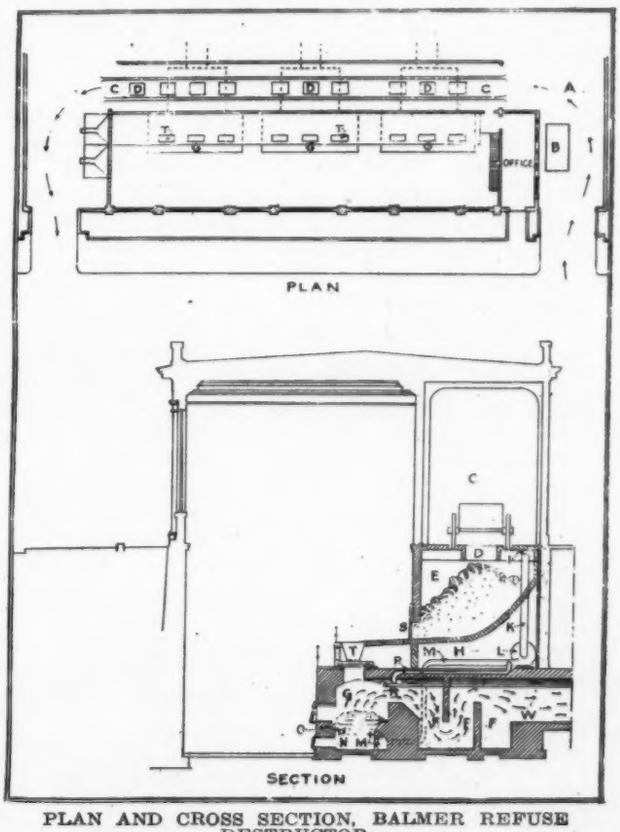
The refuse storage bins run parallel with and above the batteries of furnaces. They are built of reinforced concrete and form part of the structure of the runway or bridge which spans the whole plant and over which the refuse trucks pass on their arrival at the plant. These bins are of ample capacity for receiving a whole day's supply of refuse, with additional space for emergencies.

Two flues connect each battery with a combustion chamber in the rear, which contains two baffle walls which alter the course of the gases and precipitate floating dust. The chimneys are of reinforced concrete with firebrick lining and are 114 feet high.

The entire plant is covered with a building of fine appearance. Hot and cold baths and a large, well-furnished rest-room and laundry are provided for the staff.

The site on which the destructor is placed is central, it adjoins the principal municipal garage, and the topography of the site is such that a ramp is unnecessary, but teams can drive from the street directly on to the charging floor, while ashes and clinker are withdrawn at a lower level, which also is street level. The several movements of the refuse between dumping, storing and burning are all effected by gravity. The only mechanical operations are those of the fan blowers which supply the forced draft, and the feed hoppers which load the refuse into the furnaces.

Garbage, rubbish and ashes are all collected together. Each route in the city has its own peculiarities as to composition of refuse, and each vehicle has its own route. Consequently the operator knows by the number of the vehicle the approximate nature of the refuse that



PLAN AND CROSS SECTION, BALMER REFUSE DESTRUCTOR

it brings to the plant and he therefore can readily determine which bin it is best to dump the truck into. The number of each furnace is exhibited conspicuously on the walls of the runway or dumping floor, and each truck driver on arriving at the destructor is given the number of the furnace to which his load is assigned.

On entering this runway the wheels of the truck are engaged by guide rails of channel iron. Between these rails, in the floor of the bridge, are the trapdoors through which the refuse is discharged into the storage bins. When a truck has passed over the trapdoor to which it is assigned, it stops and the trapdoor is lifted in the direction opposite to that of the truck's movement. As the door is lifted, a bar that is countersunk in its upper surface swings out automatically and holds the door in a position inclined slightly from the vertical. The truck body is then tilted backward and the refuse dumped through the opening, the inclined door acting as a stop to prevent objects from being thrown beyond the opening onto the floor. As soon as the empty truck body is returned to normal position the door is closed and the truck moves on. Two men assisted the truckman in dumping the trucks, raising the doors and kept the bridge floor clean. The amount of refuse delivered daily exceeded 200 tons.

In the storage bins the refuse is heated indirectly from the furnaces below. It is drawn out by rakes into the mechanical feed hoppers, into which it falls by gravity. These hoppers are set directly over the crowns of the furnaces, into which they are discharged by the operator from the floor below, the refuse falling directly on to the fire grate.

Clinker is removed by means of special tools used through the furnace door and is loaded on to specially designed trucks. After the clinker has been removed from a fire grate, a new fire is started by dropping a charge of light material on to the fire grate, when the heat from the other grates under the same crown ignites this charge.

Between the floor of the storage bin and the crown of the combustion chamber, above which it is suspended, there is a closed hot air chamber which is heated by radiation from the combustion chamber. This hot air chamber distributes heat evenly through its roof, which is also the floor of the storage bin, to the refuse in the bin.

The forced blast draws its air from the storage bin by means of pipes and flues and discharges the air through piping and channels to the ash pits and combustion chamber of the battery which it serves. The air so used by the fans, in passing through the storage bin, absorbs the fumes, vapors and gases given off by the heated refuse. This air, therefore, is not only hot but absorbs and carries with it carbohydrates which aid in the combustion of the furnace.

It is claimed that the heating of the refuse in the storage bin is of great advantage, and is in fact the peculiar feature of the Balmer plant. "The garbage, which already arrives in a state of incipient putrefaction, develops there in the course of a few hours after arrival at the plant, a rapid and advanced fermentation which permeates throughout the mass, producing at the expense of the water content a large variety of alcohols and ethers. These carbohydrates, whether remaining in the garbage or passing off as vapor in the air supplied to the furnaces, are a valuable aid to efficient combustion. Under the action of heat, the hydrocarbons are volatilized in part, the vapors either penetrating the rest of the refuse and thus rendering it more combustible, or passing off as vapor with the air supply to the furnaces—contributing, in both cases, to accelerate and intensify combustion. In the course of the day, considerable quantities of water vapor must pass off from the heated mass of refuse, thus relieving the latter of a portion of its greatest handicap to combusition."

Official figures of refuse destroyed give this as containing 93.4 per cent. of household refuse, 2.1 per cent. of street sweepings, 3.1 per cent. of market refuse and 1.4 per cent. of miscellaneous. There is practically no ashes in the refuse. The moisture content is stated to average 55 per cent.

Special investigations were made by Mr. Staal with the consent of the city engineer of Montevideo. From these he found that the temperatures in the furnace and combustion chamber did not at any time fall below 600 degrees C. or 1112 degrees F. The CO_2 varied from about 7% to 14½%, averaging between 10 and 11.

The interval between two consecutive charges averaged nine minutes. Clinkering was done once every six hours, which was the length of shift of the workmen. In clinkering, the clinkers were drawn directly into small special carts which transport them outside where they are dumped as fill on the low land adjoining. The ashes are first dropped on to the floor and then shovelled into carts. It was suggested that mechanical contrivances would be advantageous in order to save labor in this work.

The three furnaces have a nominal capacity of 270 tons of refuse per day, and it is claimed could burn 300, although an average of 210 to 220 tons were being burned last year.

The municipal officials have for some time been promising a five-year report on the operation of the destructor, but this Mr. Staal was not able to obtain. The only official figures available were those for the year 1916, the first year of operation. During this year the furnace consumed 71,383 cart-loads of refuse weighing 151,763,392 pounds. In addition to the regular refuse, there were destroyed 2,980 dogs, 45 sheep and 26 other animals. The amount of refuse did not vary much from month to month, the minimum per month being 11,781,275 pounds and the maximum 15,211,792 pounds; in only one month, however, did the amount exceed 13,000,000 pounds. It is said that there is at no time any odor or other nuisance about the plant and that the vapors from the chimney are scarcely visible at any time.

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A. PRESCOTT FOLWELL, Editor

CONTENTS

Variations in Pavement Reinforcement

A wide variation in practice among the cities of the country is found in the weight of pavement reinforcement used. The number using reinforcement has increased greatly during the past two years, but nothing approaching standard weights has been adopted. Weights of fabric as low as 25 pounds per hundred square feet are found, and 30 pounds is common; while as high as about 85 pounds is used, and bars range from 20 to 100 pounds. Figures are given in two articles in this issue.

Of course, different traffic weights would require different strengths of pavement to meet them, but we wonder to what extent the variations in weight are based upon scientific calculations. As a matter of fact there does not yet seem to have been developed a theory for calculating reinforcement based upon any generally accepted assumptions or experimental results. The test road at Pittsburg, Cal., was expected to aid in developing such a theory, but, so far as we know, practically no conclusions have been made public that advance appreciably our knowledge of the subject. In view of the millions of dollars being spent on reinforced pavements a thorough scientific investigation of the subject is urgently needed.

Immigration and Wages

Although labor may not be a commodity, and although minimum wages may be fixed by law, the law of supply and demand will in the end prevail, we feel assured. If wages be kept too high artificially, additional substitutes for labor will be found in mechanical appliances to offset this. If the supply is kept inadequate by immigration laws wages will advance, following the law of supply and demand, and the same result — increase in labor-saving appliances—will follow. This is not prophesy; it is history of the past six years. Compare the wage rate curve for that period with the areas occupied by the road shows during the same years, allowing for one or two years' lag for the development of the machinery after the demand is realized.

During the year from July 1, 1921, to June 30, 1922, according to the U. S. Bureau of Immigration, 40,319 Italian immigrants entered this country and 53,651 left; 3,457 Greeks entered and 7,506 left; 28,635 Poles entered and 33,581 left. A large part of our unskilled labor is supplied by these countries. Result: Unskilled labor wage rates on February 1 are 90 per cent above pre-war level, while cost of living is about 56 per cent higher; and wages have risen 15 per cent during the past year.

Water Meters and Consumption

One of the most startling results of metering that has come to our notice is reported from Chicago. An extract from the report of the Department of Public Works of that city, published on another page of this issue, shows a reduction of more than eighty per cent in per capita consumption within a few months after beginning a general introduction of meters in one of the districts of the city. The report states that this "is entirely due to the installation of meters."

Engineers in Public Service and Private Practice

Many of the engineers in the various departments of public service are habitually engaging in private engineering work, and a feeling has been growing among engineers in private practice that this is unfair and unethical. It has, in fact, developed to the point where the American Association of Engineers has thought it necessary to take official notice of the condition and appoint a committee to look into the matter. This committee, of which Wm. Artingstall of Chicago is chairman, has sent a questionnaire to about 400 engineers in public service and others in private practice, asking the former for facts as to their employment and both for opinions as to whether the former should be prohibited from such competition.

Among the questions asked of private practitioners are whether private work of the "Public Engineer" should be prohibited, or restricted, or limited to consultation for other public bodies, or to straight consultation (without any office force); and whether his salary permits his giving up private practice.

The engineers in public service are asked their opinions on practically the same points, and also whether part or all of fees received should be turned over to the public departments from which they receive their salaries. The public engineers addressed include those employed by cities, counties, states, highway departments, etc., and they are asked in addition to tell (under pledge of secrecy) their salaries, whether they are expected to perform other public work aside from their regular duties and whether they receive additional compensation therefor, whether they engage in private practice with or without a private office or organization, and whether they must obtain permission for this; also whether there are any local regulations, laws or customs covering these points, and whether the one answering considers his official salary "commensurate with the duties required," and whether he would abandon private practice if the salary were adequate.

The returns from this questionnaire will at least be of interest, and will possibly furnish the argument for an effort by the society to secure legislation on the subject by city, county and state governments.

Engineering Employment for 1923

The Employment Department of the American Association of Engineers, in its review of the year 1922, reported that employment for engineers improved steadily throughout the year, except for the customary dullness due to the usual year-end pause in engineering work.

It reports that there is every indication of a shortage of technical men during the early part of 1923. There is much demand for designers. It anticipates especially a demand for specialists on construction, particularly on buildings and hydro-electric and drainage projects; also a fair demand in the highway field. Little demand is anticipated for railroad engineers, and the same is true of the electrical field.

Salaries increased from ten to twenty per cent during 1922, although in some cases they were reduced. Last year graduates in engineering received an average of $125 per month.

Tennessee State Highway Department Reorganization

Under a re-organization bill recently introduced and passed by both houses of the Tennessee Legislature, the State Highway Department is to be known as Department of Public Roads and Buildings, to be headed by a commissioner and its chief engineer. This bill came into effect February 1, abolishing the old order of having three commissioners, representatives of the three divisions of the State and of both political factions. Under the present law one commissioner, appointed by the Governor, will head the organization, receiving remuneration of $5,000 per year, and holding the title of Commissioner of Engineering. The chief engineer's salary remains $6,000 annually, the same as under the old law. J. G. Creveling, Jr., county highway engineer of Davidson County, has been appointed by Governor Peay for this position, taking office February 1.

It is possible that legislation affecting highway revenues will be enacted during the present Legislature. Governor Peay in his inaugural message recommended a tax on gasoline sales of two cents per gallon and removing the present highway levy on general taxation.

New State Highway Commission for New Jersey

One of the first acts of Governor Silzer of New Jersey, early this year, was to remove the State Highway Commission of seven and recommend a commission of three men. The State Legislature on February 13 passed a bill providing for a bi-partisan commission of four which, although he did not approve of (because of the disadvantages of bi-partisan boards, including probability of a deadlock, proved by past history) he at once signed and sent to the Legislature nominations to the board as follows: General Hugh L. Scott, Percy Hamilton Stewart, Walter Kidde and Abraham Jelin. The nominations will be considered for confirmation on February 19. Each member receives $7,500 a year. The commission will appoint a State highway engineer to succeed Thomas J. Wasser.

Bills are pending in the State Senate providing for open specifications in building State highways.

North Carolina's Road Law

Early in February the State Legislature of North Carolina passed a bill providing for a $15,000,000 bond issue to continue the highway construction program begun with the $50,000,000 authorized in 1921. The bill also raises the tax on motor fuel oil from one cent to three cents per gallon.

Trenton Sewage Disposal

Comparison of various systems of treatment by Geo. A. Johnson results in recommendation of the direct oxidation process. Figures from the test of the Allentown plant.

The report of George A. Johnson on Sewage Disposal for the city of Trenton, New Jersey, has just been made public. It is a very complete discussion of the subject, giving in full detail the data secured by the investigations as well as his conclusions and recommendations.

Sometime before the war the State Department of Health of New Jersey directed the city of Trenton to build a sewage disposal plant and plans were prepared by Hering and Gregory in 1911 and approved by the department, but no further steps had been taken when the war stopped all work of this kind. In April, 1921, the State Department of Health refused to permit the city to make any more sewer extensions until the matter of sewage treatment had been attended to and in March, 1922, the Court of Chancery issued a mandatory injunction directing the city to adopt plans approved by the department within six months and to stop emptying raw sewage into the Delaware river within eighteen months. As a result of this, the city on June 23rd employed Mr. Johnson to investigate the subject and make a report not later than September 23rd. The report was made recommending the construction of a "direct oxidation" plant, was accepted and Mr. Johnson was directed to prepare detail plans; which plans have been presented to the State Department of Health and its engineer has recommended that a permit for construction of the plant be given.

The report gives in detail figures of past population and anticipated population, records of temperature, of sewage flow, of river flow, etc. The sewage flow was obtained at first by automatically recording the height of sewage in a manhole near the outlet of the main sewer, the height being determined by a float in a stilling box; subsequent to which the flow was measured by a current meter.

The city is sewered on the combined plan over about 20% of its area and the separate plan over the remaining 80%. In making the estimates, a plant capacity was provided to allow for 5,000,000 gallons of storm water in addition to the dry weather flow before the storm water would overflow through outlets into the river; this being about 20% of the estimated dry weather flow in 1923, or 9% of that in 1950.

"The sewage of Trenton requires treatment that the waters of the Delaware river may be constantly maintained in attractive and inoffensive condition; and that the health and well-being of the population resident in communities and scattered along its banks below Trenton may be properly conserved. Prior removal of the grosser solid matters, and the more complete dispersion of the partially clarified sewage through the flowing body of water in the river, might keep the river water attractive and odorless for most of the time, but such procedure would not satisfy the State Department of Health nor fulfil the obvious duty of the City of Trenton to its neighbors downstream."

The city had purchased before the war 60 acres of land on the river front and just below the main sewer outlet, which Mr. Johnson found to be the best obtainable for a sewage treatment plant. However, it is so situated as to surroundings that it will be necessary to minimize nuisance. The main outlet is necessarily so low that pumping will be required wherever the treatment plan be located or whatever its nature.

In his discussion of the treatment plan to be adopted, Mr. Johnson described the various processes in common use, and stated that all of these excepting activated sludge and the direct oxidation process "periodically fail to give results consistent with the desires and intent of the designers and operators. . . They also show reduced efficiencies in cold weather, and are very liable to yield unsatisfactory effluents, at least for short periods, at other times. And they all, without exception, create a nuisance in the neighborhood wherein they are located." The unreliability he attributes chiefly to the fact that they are dependent upon "the capricious activities of various forms of bacterial life."

Of all the recognized methods of sewage treatment but three are worthy of serious consideration in connection with the Trenton problem. One of these, the Imhoff tank-sprinkling filter system is barred from consideration because it is a local nuisance breeder, hence its utilization would invite trouble from nearby property owners. Furthermore, its first cost would be prohibitively high.

The Activated Sludge process is suitable for the treatment of the sewage of Trenton, but it produces larger volumes of sludge than any other type of sewage treatment, and this sludge is not only difficult and expensive to dewater and handle, but is putrescible to a far greater degree than the sludge of other practical processes of sewage treatment. It is a difficult process to manage so as to secure uniformly satisfactory results, but does produce, and with little or no nuisance, a very high-grade effluent. The sludge problem, however, remains unsolved at this date.

The Direct Oxidation process is just now receiving the recognition it deserves. You now have before you in Chapter XI the results of my tests on this system, made at Allentown last July and August. Furthermore, the result of the investigation of the Phillipsburg installation, recently made by the State Department of Health of New Jersey, have just been made available to you.

With the adoption of the Direct Oxidation process the following chief advantages will be gained:

1. A definite and permanent purification of the sewage of the City of Trenton to a degree where no valid objection to the discharge of the effluent into the Delaware river can ever be made by any of the riparian owners below.
2. Positive and permanently inoffensive disposal of the sludge produced, first, by constructing dykes about the plant and filling ground, and, later, disposition of the sludge for agricultural purposes.
3. An installation attractive to the eye in every department and bearing no resemblance whatever to a sewage treatment plant, such as the public commonly visualize in works of this character.
4. Complete freedom from odors and flies anywhere about the plant.
5. Lowest first cost of construction and at least equally low total cost of treatment as compared with other methods of sewage treatment which are less easily managed, less reliable, and which are certain nuisance breeders in some particular and in variable degree.

Specifically stated, the comparative cost of sewage treatment at Trenton by the only three processes deserving of serious consideration in these premises is as follows:

Comparative Cost of Sewage Treatment

Based on the treatment of an average daily sewage flow of 30,000,000 gallons. Plants are complete in all departments and include everything from the connections with existing outfall sewer to the new effluent discharge line into the Delaware river.

Item	Imhoff Tanks and Sprinkling Filters	Activated Sludge Process	Direct Oxidation Process
Total first cost.....	$1,983,000	$1,475,000	$1,063,000
		Per Annum	
Capital charges at 7½ per cent	148,725	110,625	79,715
Labor, power, maintenance and supplies	56,450	115,250	125,901
Total Annual Cost..	$205,175	$225,875	$205,625

In his comparison of the sludges produced by the various methods, he gives the following figures: Plain sedimentation 4.5 cubic yards per million gallons with 90% moisture; septic tank, 4.0 cubic yards with 85% moisture; Imhoff tanks, 3.0 cubic yards with 83% moisture; activated sludge 50 cubic yards with 98% moisture; chemical precipitation 25 cubic yards with 88% moisture; and direct oxidation 25 cubic yards with 94% moisture. Activated sludge is by far the largest in amount and putrifies rapidly, while experience has shown that that from the direct oxidation process remains stable indefinitely.

The plant is located on low land which is flooded during high water and it is desirable to surround it with a levee, and sludge which remains stable can be used to advantage in constructing this; the plant meantime being protected by embankments surrounding and in contact with the several structures.

Whatever type of plant be employed, it would be necessary to employ coarse screens, grit chambers, fine screens and a pumping plant, For completing the treatment, Mr. Johnson considered Imhoff tanks with sprinkling filters, activated sludge, and direct oxidation. With the Imhoff tanks, sludge beds would be provided. With the activated sludge plant, thickeners would be used and land drying, and the same for direct oxidation. He estimated the cost of the screens, grit chambers, pumping plant, and necessary sewer connection and outlet, at $400,000. An Imhoff and sprinkling filter plant at $1,583,000; an activated sludge plant at $1,075,000 and a direct oxidation plant at $663,000.

On the basis of the cost figures shown above, and believing that the direct oxidation process produces a more stable sludge and can be operated without creating any nuisance, he recommended this for Trenton. In connection with the discussion of this he referred at length to the test made last year of the Allentown plant. In making this test the plant was operated not only in the normal way, but also using electricity alone without lime, using lime alone without electricity, and applying 2/3 of the lime ahead of the electrolizer, and a fifth plan of applying 1/3 of the lime ahead of the electrolizer. The average amount of lime used under the normal method of operation was 1,500 pounds per million gallons, when operating with lime alone the amount averaged 1525 pounds; when 2/3 was applied ahead of the electrolizer the amount averaged 2070 pounds and when 1/3 was applied it averaged 1706. The last two methods used are known as split dose D & E respectively. The accompanying table shows the average percentages of removal by the five methods of operation.

Average Percentage Removal of Principal Constituents of Allentown Sewage by Different Methods of Operation.

Constituents	Elec. Alone	Lime Alone	Normal	Split Dose (D)	Split Dose (E)
Suspended matter					
Total	37.0	10.0	45.2	20.6	12.1
Volatile	+8.3	10.6	54.0	25.0	4.0
Oxygen consumed....	6.7	24.0	45.3	40.0	40.
Organic nitrogen					
Total	14.5	17.5	44.7	45.7	31.3
Dissolved	+8.3	34.4	34.0	27.6	52.6
Free ammonia	0	37.5	40.0	29.0	52.0
Total bacteria (37°C)	31.0	94.6	99.0	93.0	94.0
B. Coli	0	95.6	99.99	97.0	93.0

+means increase.

Commenting briefly on the above results it is to be stated that no marked deviation from the average was found in the individual results, and when the electrolyzers were operated at full capacity the results were as satisfactory as when the rate of treatment was considerably lower. The results herein recorded, therefore, may safely be taken as equally representative of the efficiency of the process under full rated load.

(Continued on page 71)

Replacing Trenches in Streets

Requirements of cities concerning cuts made in city streets and the backfilling and repaving of them.

A large number of cities have filled out our questionnaire concerning their procedure in connection with the opening of streets by private individuals or corporations for the purpose of laying pipes, making repairs, etc., and, especially, the replacing of the excavated material and pavement. At the time of making this summary 440 cities have reported, although more are coming in daily and will be added to the tabulation. These 440, however, are found in all but four of the states of the Union and it is believed that they represent the general practice of the country.

We find that of these 440 cities, by far the largest number require the backfilling of the trenches to be done by the plumbers, contractors or others acting for private parties who made the street opening. However, 72 cities perform their own backfilling with their own employees, 10 additional ones do so wherever the street is paved, 4 do so except where the cut was made by a public utility company, and 7 others do the backfilling in some cases (conditions not stated) and allow private parties to do so in others.

In replacing the pavement, however, we find an unexpectedly large number of cities performing this work themselves. Of the 440, 276 report that all pavements are replaced by the city, either by their own forces or, in a few cases, by paving contractors under contract with the city. In 5 cities the public utilities only are permitted to repave over cuts made by them, presumably because they have men in their employ experienced in this work. Four of the cities replace with their own forces a certain kind or kinds of pave-

ment, allowing other kinds to be replaced by private individuals; while in 11 other cases the city sometimes does this work itself and sometimes permits others to do it under conditions not stated.

Five cities make no charge for the work done in replacing the pavement, but all the others make charges by various systems. Fifty-eight cities have regular schedules, most of them regulating the charge by the kind of pavement replaced as well as by the area. The great majority, however, charge the actual full cost of performing the job in question, including both labor and materials. The cost alone is charged by 171 cities, but a number of others charge the cost plus a certain percentage, this percentage being 5 per cent. in three cases, 10 per cent in sixteen cases, 12 per cent. in one case, 15 per cent. in one case, 20 per cent. in five cases and 25 per cent. in one case, while two charge the cost plus $5.00 and one the cost plus $2.00.

Where the backfilling is done by the parties by whom the opening in the street is made, an undesirably large number report no regulation of the manner in which the backfilling is done. It is probable, however, that in some cases where this report was made, the city engineer or other official can require the work to be done to his satisfaction, forty-four cities reporting that the filling must be done to the satisfaction of the city engineer, street superintendent or some other city official. Seven have as the chief requirement that all the dirt that was excavated shall be put back into the trench. Eighteen require that the street be returned to a condition equal to that in which it was found. Most engineers will recognize that this is impracticable in the majority of cases, and two cities recognize this by requiring that it be returned to as nearly as possible the original condition. It is interesting to learn that fifteen cities require that, where the streets are paved, the material excavated be removed and the trench be filled with sand or gravel, this sand or gravel being thoroughly compacted either by ramming or, in a number of cities, by saturating with water.

The majority of cities, however, have regulations for the compacting of the backfilling, some as parts of the ordinance and some as regulations of the department of public works, city engineer, etc. Quite a number require tamping in layers of specified thickness, this varying from a minimum of four inches to a maximum of twelve inches, six inches being the most common thickness specified. Quite a number require that on paved streets the pavement itself be cut back a distance from the side of the trench varying from six inches to a foot in the different cities, thus affording a shoulder of solid earth to support the new concrete base, which concrete base in some cities is reinforced and in a few is made thicker than the base under the rest of the pavement.

As a whole, the reports show that a very gratifying amount of attention has been paid to this important subject by the various cities, while several state that the problem is receiving attention and improvements in the regulations are under consideration.

Concrete Pavement Reinforcement

Kind and weight of reinforcement used by each of one hundred cities in constructing concrete pavements.

The following information concerning the use of reinforcement in concrete pavements has been furnished to us by the several cities named. This information in general applies to the concrete pavement which is to be laid during 1923. Unless otherwise stated the weights are per hundred square feet.

Fort Collins, Col., will use 4-inch by 8-inch mesh. New Britain, Conn., will use 34-lb. fabric. Americus, Ga., has been using 4.7-lb. fabric per square yard.

Benton, Ill., will use 33 to 36-lbs. Canton, Ill., will use fabrics of standard weight. East Moline, Ill., uses National Steel Fabric Company 43.6-lbs. Edwardsville, Ill., uses 32-lb. fabric on some work and 62-lb. on other. LaGrange, Ill., uses 40-lb. fabric. Mattoon, Ill., 40-lb. mesh. Monmouth, Ill., 51-lb. fabric. Naperville, Ill., 36-lb. fabric. Ottawa, Ill., 36-lb. wire mesh. Pana, Ill., 40-lb. fabric. Riverside, Ill., American Steel Wire Company 35-lb. mesh. Waukegan, Ill., 35-lb. fabric.

Boonville, Ind., 30-lb. Fort Wayne, Ind., 40-lb. Gary, Ind., 34-lb. fabric. Huntington, Ind., 40-lb. fabric. Winchester, Ind., fabric and bars, about 50 lbs.

Clinton, Ia., ½-inch square bars spaced 6 feet each way. Decorah, Ia., 30 to 40-lb. bars now used, mesh used previously. Ottumwa, Ia., ⅜-inch bars, 75 lbs.

Corbin, Ky., 35-lb. fabric. Lexington, Ky., 40-lb. fabric. Paducah, Ky., ¾-inch round bars 30 inches from the edge and from the center line. Bangor, Me., ½-inch deformed bars 85 lbs.

Brockton, Mass., bars 94 lbs. Greenfield, Mass., bars 80 lbs. Pittsfield, Mass., bars 27 lbs. Worcester, Mass., bars 75 lbs.

Grand Rapids, Mich., 25-lb. fabric. Pontiac, Mich., 65-lb. fabric. Duluth, Minn., 32-lb. mesh. Mankato, Minn., 40 lbs. South St. Paul, Minn., 60-lb. fabric in 10-inch concrete pavement. Brookfield, Mo., 40-lb. fabric. Hannibal, Mo., 45-lb. fabric for 30-foot width or over, 25-lb. for less width. St. Louis, Mo., 40 lbs. Butte, Mont., bars 51 lbs. Fremont, Neb., 32-lb. fabric.

Cape May, N. J., 40-lb. fabric. Millville, N. J., 58-lb. fabric. Phillipsburg, N. J., 65-lb. fabric.

Amsterdam, N. Y., 28-lb. fabric. Cohoes, N. Y., 40-lb. Gloversville, N. Y., bars 50 to 85-lb., depending on subsoil. Herkimer, N. Y., 71 lbs. Lackawanna, N. Y., will use bars, weight not determined. Little Falls, N. Y., two layers of fabric each 40 lbs. Lockport, N. Y., mesh 41 lbs., bars 83 lbs. Massena, N. Y., 65 lbs. mesh. Olean, N. Y., 75 lbs. Schenectady, N. Y., 60-lb. to 100-lb. bars. Greensboro, N. C., fabric. Fargo, N. D., 40-lb. fabric.

Grand Forks, N. D., ½-inch round bars along edges of blocks and 30-lb. fabric for 20-foot pavement and 40-lb. fabric for over 20 feet. Wahpeton, N. D., ½-inch transverse bars spaced 18 inches centers.

Bellaire, O., 56-lb. fabric. Bucyrus, O., 56-lb. fabric. Cincinnati, O., 28-lb. fabric. Dayton, O., 28-lb. fabric. East Youngstown, O., 56-lb. fabric. Ironton, O., 28-lb. fabric. Marion, O., 50-lb. fabric. Ravenna, O., 34-lb. fabric. Struthers, O., 56-lb. fabric. Wooster, O., 56-lb. fabric. Muskogee, Okla., bars along edges and slab dowels.

Allentown, Pa., 54-lb. mesh and 25-lb. mesh. Bangor, Pa., 56-lb. fabric, bars at all joints. Blairsville, Pa., 28-lb. fabric. Catasauqua, Pa., 27-lb. fabric. Clairton, Pa., 65-lb. fabric. College Hill, Pa., 32-lb. fabric. Easton, Pa., 56-lb. fabric. Hazleton, Pa., 50-lb. fabric. Lebanon, Pa., 33-lb. fabric. Monongahela, Pa., 56-lb. Munhall, Pa., 48-lb. Sayre, Pa., 65-lb. Tyrone, Pa., 65-lb. fabric.

San Benito, Tex., 20-lb. bars. Salt Lake, Utah, 45 to 50-lb. fabric. Barre, Vt., 30-lb. fabric. Bennington, Vt., fabric. Rutland, Vt., 22½-lb. bars. Clarksburg, W. Va., 56-lb. fabric. Manitowoc, Wis., 33 and 48-lb. fabric. Ripon, Wis., 55-lb. Stevens Point, Wis., 28-lb. fabric. Wisconsin Rapids, Wis., 40-lb fabric. Casper, Wyo., 28-lb. fabric.

Bonds and Deposits for Trenching Permits

Practices of the various cities in requiring guarantees that trenches and pavements excavated by private parties will be properly replaced and maintained.

Most and possibly all cities and boroughs require that a contractor, plumber or other party wishing to dig a trench or make any other opening in a street surface shall obtain a permit for doing so from the proper authorities. Ordinarily there is a charge of from $1.00 to $5.00 per permit. In addition to this, some cities require that a bond or deposit be furnished to cover any cost to which the city may be put in replacing the pavement, where such replacing is done by city forces; or to insure that the parties opening the trench will conform to the ordinances and regulations of the municipal department having jurisdiction. Reports on this subject have been made to us by a number of cities, which reports are assembled briefly in the following paragraph:

New Britain, Connecticut, requires the contractor to furnish bond. Waukegan, Illinois, requires the contractor to deposit with the city the amount which the city engineer estimates will cover the cost to the city of replacing the trench and the pavement. In Marion, Indiana, contractors and plumbers who do work of this kind are placed under a bond which we presume is supposed to be adequate to cover all the work that they may do. Richmond, Indiana, requires a deposit to be made before a permit is granted sufficient to cover cost to city of backfilling and paving plus 12 per cent. In Shelbyville, Indiana, the contractor gives a bond to replace the street in first-class condition, and this is the practice in Winchester, Indiana, also. In Creston, Iowa, the contractor deposits the estimated cost of backfilling and repaving by the city before the permit is issued, and this is the practice in Waterloo, Iowa, also. In Independence, Kansas, the contractor is required to give bond to keep the restored excavations in repair. In Salina, Kansas, contractor gives cash bond to refill trenches and replace pavement satisfactory to the city engineer. Corbin, Kentucky, requires a bond, and Paducah, Kentucky, a bond or a cash deposit to assure his reimbursing the city for cost of backfilling and repaving trench, and in addition requires an indemnity bond to protect the city against lawsuits or accidents. Faribault, Minnesota, requires a bond conditional on replacing the street in its original condition, which the engineer reports is difficult to enforce and does not secure satisfactory work. Contractor's bond is required by Mankato, Minnesota, and Brookfield and Excelsior Springs, Missouri, to replace the pavement in good condition. In Billings, Montana, a surety bond is required. In Laconia, New Hampshire, a deposit is required. In Camden, New Jersey, a deposit is required of $10 on old 6-inch asphalt streets and $20 on new 8-inch asphalt streets, in addition to which the plumber is under an annual bond of $500; moreover, the department refuses new permits to plumbers flagrantly derelict. In Freehold, New Jersey, a $10 deposit is required. In Roselle Park, New Jersey, the cost of laying new pavement is collected when the permit is issued. In Amsterdam, New York, a deposit or bond is required, amount of deposit returned being based on cost of replacing pavement and condition of trench after six months. Lockport, New York, requires a bond to be filed. In Manhattan Borough, New York, public service corporations restore the pavements, but a deposit equal to the estimated cost of restoring pavement is held for six months and used to repair any settlement during that time. In Elyria, Ohio, a deposit must be made when permit is granted covering cost to city of repaving plus 15 per cent. Lakewood, Ohio, requires deposit in advance to cover cost to city of repaving. Lancaster, Ohio, requires cash deposit of $10, held for six months. In Wooster, Ohio, the contractor refills and repaves, but makes deposit to guarantee proper work. In Butler, Pennsylvania, a bond is required of $2 per foot of trench. In Chambersburg, Pennsylvania, a deposit is required and the cost of repaving by borough deducted from it. In Clairton, Pennsylvania, bond or deposit is required. In Greensburg, Pennsylvania, a $50 deposit is required. In Cranston, Rhode Island, contractor must pay city, on obtaining permit, stated amount for replacing pavement. Dallas, Texas, and Bluefield, West Virginia, require deposit to cover cost to city of replacing pavement. Tomahawk, Wisconsin, requires bond to cover returning trench to "original condition."

Municipal Paving in Massena

Village did thirty-eight thousand dollars of force account paving for about a thousand dollars below the low bid, using municipal plant costing about four thousand dollars and hiring teams and some equipment.

During the summer of 1922 the village of Massena, N. Y., paved three streets totaling 4,408 feet in length, together with side curb, with municipally hired labor and municipal apparatus, the following information concerning which has been furnished by W. E. Timmerman, village engineer:

Before the village decided to do this work itself, it advertised for bids, but after receiving bids decided to do the work itself. Work was started on July 12th and completed Oct. 17th. The work would have been completed about Sept. 30th had not the last shipment of cement been delayed nearly two weeks by conditions of freight traffic. One of the advantages of local construction was that 60 per cent. of the materials and supplies were purchased through local dealers and 75 per cent. of the labor cost was distributed among men residing in the village.

The work to be done included grading, in connection with which several hundred yards of old macadam were removed and gravel placed on dirt streets that needed repairs. The paving was all concrete, mixed 1:1½:3. The concrete for curb was mixed 1:2:4. Reinforcement was used in the form of welded steel wire mesh, 65 lbs. per 100 sq. ft., and ½-inch round corrugated iron bars 10 feet long bent to a right angle and placed at each corner of each 33-foot block. Carey elastite ½-inch by 6 inches was used for expansion joints. The subgrade was crowned, thoroughly rolled and compacted with a 10-ton roller. The pavement was made uniformly 6 inches thick and was constructed one-half the width of the roadway at a time. The curb was made 6 inches by 18 inches with a 2-inch batter on the back and was set on a foundation containing 3-inch porous drain tile with joints protected by 3-inch strips of 2-ply tar paper, imbedded in 8 inches of cinders, wet and tamped.

EQUIPMENT AND ORGANIZATION

The equipment used consisted of a Ford truck, steam roller, teams hired at $5 per 8-hour day; screen, elevator and bins operated by a 9 h.p. gasoline engine rented at $1 per working day; drag scrapers to haul gravel from bank to hopper; a Rex 10-E paver mixer, steam operated, chute discharge, bought second hand for $1,500; and a Sheldon gasoline operated barrel mixer for curb concrete, bought new for $147.50.

Common labor received $2.75 for 8 hours. The owner of the gravel pit received 25c per cubic yard for gravel measured in place in the pavement. Cement was bought through local dealers at $2.98 per barrel, net.

The gravel was hauled from the bank into the hopper with drag scrapers, which averaged 90 cubic yards per day. Here it was elevated and screened and everything passing through a ½-inch circular screen was classed as sand, and the larger material passing through a 3-inch circular screen was used for coarse aggregate. The hauling of the aggregate was sublet for 85c per cubic yard measured in the truck box, the average haul being 2¾ miles.

The field party consisted of a transitman, rodman and chainman, the last acting as timekeeper. The pit gang consisted of a foreman, a mechanic, 12 laborers and three teams. The grading gang consisted of a foreman, 15 laborers and two teams. The curb form gang consisted of a boss carpenter, a helper and a laborer. The curb concrete gang consisted of one foreman (who was also the finisher), and six laborers. The

ONE HALF OF NORTH MAIN STREET COMPLETED

paving concrete gang consisted of a foreman, engineer, fireman, mechanic and 18 laborers. The Ford truck was served by a chauffeur and helper; the steam roller by one operator.

WORK DONE

The North Main Street job consisted of pavement 2,450 feet long and 24 feet wide containing three intersections, on which was laid 1,109.8 cubic yards of concrete pavement and 5,000 lineal feet of curb. The time required to complete this job included 16 days of grading, 23 days on curb excavation, 30 days on curb forms, 28 days on curb concrete and 19 days on paving. Grading began with the entire grading gang on July 12; on July 16 the curb gang started, and on August 1, the paving was started, when all but 6 of the grading gang were put to work with the paver; leaving a reduced grading gang to grade the other two streets.

The Water Street job was 933 feet long, 635 feet of this being 30 feet wide and the balance 24 feet wide, with one intersection. It included 1,837.7 lineal feet of curb and 484.4 cubic yards of concrete pavement. Nineteen days were occupied in grading, 13 days in curb excavation, 12 days on curb forms, 12 days on curb concrete and 8 days on paving.

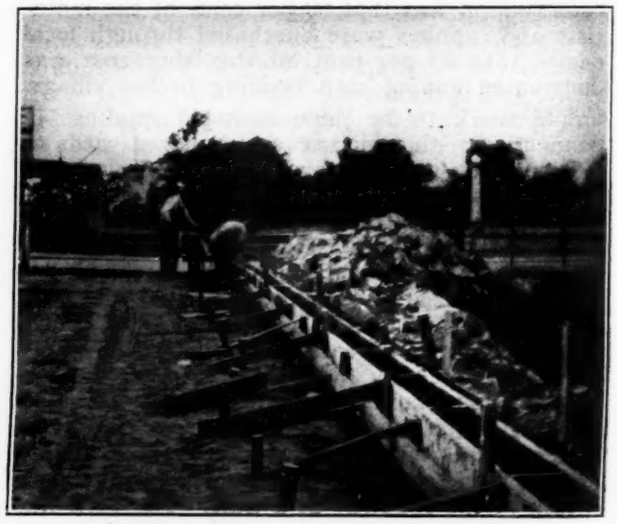
The Bridges Avenue job was 1,035 feet long, 400 feet of which was on a curve around a park. It was 24 feet wide and contained five intersections. There were 2,010 lineal feet of curb and 521.7 cubic yards of concrete pavement. Grading occupied 19 days, curb excavations 15 days, curb forms 14 days, curb concrete 13 days and paving 12 days. On account of delay in receiving cement, the labor force on this street was reduced one-half.

SCREENING OUTFIT

COSTS

The itemized cost of the work is shown in the accompanying table. Item No. 2 includes those given as 4-A, 6 and 7 and also the cleaning of the finished pavement and grading alongside the curb and sidewalk. The "overhead" includes engineering, office, printing, bank interest and freight charges. The engineer's estimate before receiving bids was $39,352.75. The cost of the plant used was $3,741.46, which was estimated to have a value at the end of the contract of $3,086.05, giving a depreciation of $655.41 to be added to the cost given above. Using the unit price of the lowest bidder on the work, the cost by contract would have amounted to $39,200.43.

In estimating the cost of the sand and gravel, the cost of the screening plant complete for operation was $762.82; the labor cost, including stripping, was $3,791.56, and miscellaneous supplies, $178.76; giving a total cost of $3,970.32. The total output of gravel and sand for the season was 3,857.7 cubic yards, giving an average cost of screening of $1.03 per cubic yard. The screening yielded an excess of sand amounting



METHOD OF PLACING CURB FORMS

to about 500 cubic yards, which has been put into a stock pile for future use.

COSTS

No.	Item	Quantity	Unit Cost	Total Cost
2	Earth excavation	1500 CY		$3045.57
4A	L. F. 15-in. tile	180		
6	Catch basins	9		
7	Changing elevation of M. H.	16		
8	C. Y. cement concrete pave. 1:1½:3 mix	2115.94	4.79	10135.35
8A	Bbls. Portland cement	4021	2.98	11990.58
8B	Expansion joint L.F.	12148	.08	971.84
9	L.F. 6-in. by 18-in. curb	7848		
	L.F. 6-in. by 18-in. curb (curve)	1000	Aver.674	5963.55
10	Sq. ft. metal reinf.	112265	.03	3367.95
11	Lbs. misc. iron and steel	10000	.03	300.00
	Overhead			2159.79
	Total			$37834.63

UNIT COSTS
Per Lineal Foot

Curb	North Main St.	Water St.	Bridges Ave.
Tile	.05	.05	.05
Cinders	.01	.01	.01
Forms	.01	.01	.01
Cement	.136	.159	.141
Sand	.026	.026	.026
Stone	.058	.058	.058
Supplies	.008	.017	.016
Labor	.308	.343	.371
Deprec.	.02	.02	.02
	$0.626	$0.693	$0.702

AGGREGATE AND REINFORCEMENT DEPOSITED ALONG ROAD

Per Cubic Yard

Paving		
Cement	5.348	5.345
Sand	.778	.778
Stone	1.700	1.700
Reinf.	1.520	1.520
Exp. joint	.555	.555
Supplies	.157	.200
Coal	.040	.040
Ford operation	.302	.302
Depreci.	.200	.200
	$12.120	$12.295

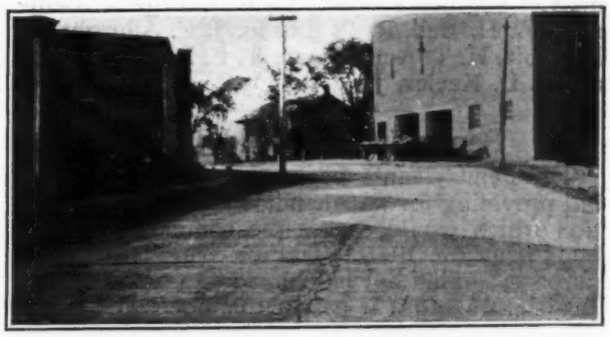
Motor Taxes in Michigan

The Michigan Legislature in 1921 appointed a joint legislative committee of inquiry into taxation which has reported to the 1923 legislature a number of findings and recommendations. Among these two are of special interest to owners of automobiles. The first is "that there should be a graduated tax of $25 to $250 on motor trucks and buses operating on State highways, and that the control of these vehicles should be vested in the public utility commission." The second is that "a tax of 1 cent per gallon should be levied upon gasoline for the support of public highways."

Federal Aid Roads in 1922

The Bureau of Public Roads reports that during the year 1922, 7,469 miles of road projects were completed and 17,978 miles were under construction and approximately half completed. Federal aid to the amount of $166,911,552 was actually paid out to the states.

Texas had the largest completed mileage for the year, 933, while more than 500 miles was completed by each of the states of Arkansas, Georgia, Iowa, Minnesota and North Carolina. Texas also received the largest payment of federal aid, this amounting to $5,915,046, while nearly $2,500,000 more was earned. Between $4,000,000 and $5,000,000 was paid during the year to each of the states of Illinois, Iowa, Ohio and Pennsylvania.



COMPLETED PAVEMENT WITH BANKED CURVE

South Carolina Road Work

South Carolina during 1922 built 80 miles of hard surface roads at an average cost of $24,025 a mile; also about 500 miles of top-soil or sand-clay roads at an average cost of $6,643 per mile. The total expenditure for highways and bridges was nearly $6,000,000.

At the first of this year more than $5,000,000 of construction work had been either contracted for or projected. This is entirely independent of the road-building program contemplated by the proposition to be submitted to the voters of raising $50,000,000 by road bonds.

Virginia's New Highway Department

A reorganization of the State Highway Department of Virginia was required by acts of the 1922 General Assembly, and the reorganization became operative on January 1, 1923.

The new department is in charge of five commissioners, selected from the five geographical divisions of the State but each representing the whole State rather than his division. One member of the commission is to be chairman and devote his entire time to the work and will be the executive of the commission.

There will be two principal departments, executive and engineering, the former having sub-departments of auditing, purchasing, legal, right of way, and statistical and filing.

Engineers have been appointed by George B. Coleman, state highway commissioner of Virginia, in his plan for reorganizing the engineering branch of the department. The assistant engineers will be C. S. Mullen, in charge of construction; J. J. Forrer, in charge of maintenance; W. R. Glidden, in charge of bridges; A. H. Pettigrew, in charge of state aid; B. P. Harrison, in charge of service; Tazewell Ellett, in charge of office; Shreve Clarke, in charge of tests; and E. M. Evans, in charge of equipment.

Eight districts have been laid out, each to be in charge of a district engineer, while each district will be sub-divided into five residence districts, each in charge of a resident engineer. The

district engineers selected are: George T. Lemmon, A. H. Bell, R. P. Ellison, J. C. Albright, C. D. Scott, H. T. Ammerman, T. F. Loughborough and J. D. Keeler, Jr.

Pennsylvania Road Bonds

The Pennsylvania Legislature is considering a bill providing for an amendment to the Constitution which would enable the commonwealth to bond itself for $100,000,000 for road construction purposes. This bill has already passed the 1921 Legislature and if it passes this one will be submitted to the people, probably at the election in November, 1924, and, if it is approved then, the 1925 Legislature can pass the enabling legislation. The State is already bonded for $50,000,000 for good roads.

Resurfacing Assessments in Indiana

A bill is being considered by the Indiana Legislature that would transfer a large part of the cost of resurfacing streets from the abutting property owner, who now pays it, to the taxpayer. The bill provides for creating a special fund by a tax levy not exceeding 5c. on every $100 of taxable valuation. Seventy-five per cent. of all street repairing and resurfacing would be paid from this fund, the other 25 per cent. being charged against the owners of the abutting property.

Tests of Relative Road Wear

The U. S. Bureau of Public Roads last year prepared, at the Arlington Experiment Station, a test road for investigating the relative wear of various concrete surfaces and also of bituminous mixtures of different qualities. For this purpose a circular roadway was built 625 feet in outer circumference. A concrete track is on the outside of the circular roadway, while immediately adjacent to this and within it is a track paved with bituminous surfaces.

There are 62 sections of concrete road paved with different qualities of concrete. These are being subjected to the wear of rubber-tired truck wheels. The inner track is composed of 27 sections of asphaltic concrete of different mixtures. The bituminous pavement will be subjected to actual motor truck traffic for the purpose of studying the laws governing the stability of bituminous mixes. "This investigation has been instituted with the idea of rendering bituminous roads less likely to wave under traffic." Before beginning the experiments, measurement of the profile of the surface was taken with an autographic profile device contrived especially for this purpose. The profile measurements will be repeated at frequent intervals as the tests progress in order to determine the location and amount of wear or other deterioration of the surface. The lack of stability of the bituminous pavement will be studied by means of brass plugs placed in the surface with their positions exactly noted.

In the test of the concrete track a special contrivance is used which rolls on the concrete and is guided by wheels traveling on rails. Two solid rubber-tire wheels loaded with 600 lbs. per inch width of tire (approximately that of a 5-ton truck) will travel over the pavement at a speed of 20 miles an hour, the power being transmitted as current to a motor on one of the wheels which will thus act as the drive wheel of a truck. These wheels can be run continuously in a single track, or can be moved toward or away from either edge, and the weight can be varied. Traveling at 20 miles an hour around a circumference of 625 feet would mean that this pair of wheels would pass over each section of pavement 1,350 times in an eight-hour day.

State Zoning Enabling Act

Some time ago an advisory committee on zoning was appointed by Secretary Hoover consisting of Edward M. Bassett, Irving B. Hiett, John Ihlder, Morris Knowles, Nelson P. Lewis, J. Horace McFarland, Frederick Law Olmsted and Lawrence Veiller. This committee prepared a form for a state zoning enabling act which it recommends be adopted by the various states, with certain additions conforming to the practice of the several states such as the title and enacting clause, repeal clause, date of taking effect, etc. A revised edition brought up to to January, 1923, is ready for distribution by the Department of Commerce at Washington.

The committee recommends that this enabling act be adopted in each state, even though it may be thought that the powers contained in home rule charters are sufficient to enable a municipality to undertake zoning without any special legislation. Some zoning ordinances have been set aside because the municipality had not been granted the specific power to do that which zoning implies, and the safest procedure would seem to be to adopt this enabling act in every state. No amendment to the state constitution is necessary, as a rule, since zoning is undertaken under the police power and is well within the powers granted to the legislatures of the various states by the state constitutions.

Improvement District for Sea Wall

County Engineer A. B. Pimm is working on plans for a sea wall along a boulevard extending from the city limits of Tampa, Florida, half the cost of which will be borne by the county and the remaining half by property owners lying within an improvement district which it is proposed to have created by special legislation. The proposed legislation provides that assessments be made on property holders on a graduated scale for a distance of 2,800 feet back from the boulevard along which the sea wall will run.

Present plans provide for construction of a sea wall 120 feet from the property line, there being a 10-foot sidewalk adjacent to the property, a 24-foot paved highway, a 50-foot parkway for streetcar tracks, another 24-foot paved highway, and a 10-foot sidewalk adjacent to the sea wall. The sea wall will be 8 feet high and quite similar to one now existing in the city, with lighting standards at regular intervals.

Paving Statistics of Cities

Information furnished to Public Works by city officials, giving kinds and amounts of pavement laid in city streets during 1922, and information relative to reinforcement used, practice as to replacing cuts made in pavements by private parties, payment for paving and repaving, and other details.

The information concerning paving in city streets which we have collected this year, as for the past fifteen years, through the kind co-operation of city engineers, superintendents of streets and other city officials, is so abundant in amount that it has been found impracticable to give it all in this issue, but readers will find in the following tables and in the articles on "Pavement Reinforcement," "Bonds and Deposits for Trenching Permits" and "Paving Notes" information that will well repay careful reading. The balance of the tables will be published in a following issue, giving the areas and costs of the various kinds of pavements not covered in this one. Also, replies to our questionnaire are continuing to come in and supplementary statistics compiled from these will be published later.

In the table, "Replacing Trenches," the questions asked were: "Who backfills street trenches, city or party who opens them?" "Who replaces pavement?" "If city backfills or replaces, what charge is made to the parties who did the excavating?" "What special regulations have you for backfilling trenches?" In tabulating the replies to the first question, the word "owner" is used to designate plumber, contractor or other party presumably hired to dig the trench by the owner of the property for whom a service is laid or the owner of the pipe or other structure for which the trench is dug, as distinguished from city employes or departments. A summary of the information in this table is given elsewhere in this issue.

In the table, "Payment for Repavement," the questions asked were: "What percentage of original pavement is paid by abutting property?" "What percentage of repaving is paid by abutting property?" "Are sand-clay, gravel and macadam classed as 'pavement' in applying this regulation or law?" The chief reason for the last question is that in some cities a property owner who has paid for a avement in front of his property is not required to pay for repaving when this is worn out, but macadam is not considered to be a pavement and a pavement that replaces macadam must be paid for by the abutting owner.

In the tables giving amount and cost of pavement laid, reference is made to city streets only; areas are given in square yards (square feet for sidwalks) unless otherwise stated, and costs are per square yard (except for sidewalks) or for the entire improvement. Foot notes indicate the features of the improvement that are covered by the cost, these ranging, with all variations, from laying a wearing surface on an old base to grading, base and top, laying sewers, building catchbasins, curbs and sidewalks, with cost of inspection, advertising for bids, etc., all combined in one figure and divided by the yardage of pavement laid.

Some of the information contained on the questionnaires returned could not well be given in tables or footnotes and much of this has been written out in the form of "Paving Notes," which give details of unusual features of paving work.

(Continued on page 74)

REPLACING TRENCHES

For brevity, the word "owner" is used below to designate the party opening the trench—corporation, plumber, etc.

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Alamaba				
Birmingham	Owner	City	Estimated actual cost	Tamp in 6-in. layers
Arkansas				
Searcy	Owner	City	.....	None
California				
El Centro	Owner	City	Actual cost	None
Oakland	Owner	City	Cost	City Supervision
Riverside	Owner	City	Cost plus 10%	Dry tamp on paved streets
Santa Rosa.....	Owner	City	Cost	Tamp in 4-in. layers, settle with water
So. Pasadena.....	Owner	City	$3.15 per sq. yd.	Put back all the dirt
Vallejo	Gas Co. its trenches, city all others	Same	.....	Tamp carefully, pav't equal to that removed
Visalia	Owner	City	Cost	Thoroughly puddle
Whittier	Owner	City	Cost	Flood and tamp
Colorado				
Denver	Owner	City	$5.00 per sq. yd.	Tamp in 6-in. layers, city supervision
Fort Collins.....	W. W. City; other, owner	Same	Actual cost	Tamp around structures and puddle
Longmont	Owner	City	.....	Puddled, satisfaction of street com'r
Monte Vista.....	Owner	.....	.....	Generally puddle
Pueblo	Owner	City	.....	Wet and tamp
Connecticut				
Ansonia	Owner	Owner		By person satisfactory to city engineer, under inspector if he wishes
Bridgeport	Owner	City	Cost	.....
Bristol	Owner	Owner or city	Total cost	Leave as good as found

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Connecticut (Continued)				
Greenwich	Owner	Owner	.....	.....
Hartford	Owner	City's contractor	.....	Tamp suitable material in 6" layers, or puddle
Middletown	Owner	Owner; sheet asphalt by paving contractor	Owner pays contractor	
New Haven	Owner	City	Cost	.....
New Britain	Owner	City	$3 per sq. yd. on macadam base, $5 on concrete	.....
Putnam	Owner	Owner	.....	.....
New London	Owner or city	City for permanent pav't	Cost plus 10%	Approval of street sup't. Rules printed on permit
Willimantic	Owner	City	Actual cost	None
Delaware				
Wilmington	Owner	City	.....	Tamp by hand or machine
District of Columbia				
Washington	Owner	City	Various	Special regulations
Florida			.....	
Key West	Owner	City	$5 per sq. yd.	Water tamp
Tallahasse	Owner	Owner	.....	.....
Georgia				
Americus	Owner	Owner	.....	Ditches puddled, city inspection
La Grange	Owner	City	.....	.....
Idaho				
Boise	Owner	City	Cost	Puddle
Pocatello	Owner	City	$3 per sq. yd.	Puddle in 6-in. layers, tamp
Illinois				
Benton	Owner	Owner	.....	None
Canton	Owner	City	Actual cost	Satisfactory to street sup't.
Carterville	Owner	Owner	.....	Well puddled
Centralia	Owner	City	$4.75 per sq. yd.	.....
Champaign	City	City	Actual cost of labor and materials	Carefully tamped; slab reinforced as a beam with 12-in. shoulder on solid earth
Chicago	Owner	City	.....	Water and tamp in 6" layers
Chicago Heights	City	City	.....	Backfill with sand
Clinton	Owner	Owner	Actual cost	None
Collinsville	Owner	Owner	.....	Ordinance regulations
Danville	City	City	Cost plus 10%	Tamp in 4-in. layers; puddle if sandy soil
Decatur	City	City	Cost	City forces, direction of street sup't
Dekalb	Owner	Owner	.....	Good condition as before
Duquoin	Owner	Owner	.....	.....
East Moline	Owner	Owner	.....	Satisfy city eng'r and street com'r
East St. Louis	Owner	Owner	.....	Tamp or flood under city inspector
Edwardsville	Owner	Owner	.....	.....
Galena	Owner	Owner	.....	None
Granite City	Pub. Serv. Corp.	Same	.....	.....
Joliet	Owner	City	Brick $4.50 per sq. yd., $10 min.; asphalt, $5 for 6 yds. or less; over 6 yds., $3.50	Tamping, flooding and shoulders
La Grange	City	City	Total cost	Tamp in 6-in. layers, cover with 8-in. concrete slab 3 ft. wider and longer than excavation.
Macomb	Owner	Owner	.....	None
Marion	Owner	Owner	.....	None
Mattoon	City	City	Actual cost	None
Moline	City	City	Exact cost	Settle about 3 mos. before paving
Naperville	Owner	.....	.....	Flushing and tamping
Normal	City	City	$20 to $30	Tamped
Oak Park	Owner	Asphalt, village, brick and macadam, owner	.....	Tamp in 6-in. layers, flood where soil permits
Ottawa	Owner	Owner	.....	Tamp and flush
Pana	Owner	Owner	.....	Filled with gravel, flooded, compacted
Quincy	City	City	Dirt streets, $3 per sq. yd.; paved, $5	Tamp in thin layer; for pavement, 6-in. reinforced concrete base
Riverside	Owner	Village	.....	Puddle and tamp
Robinson	Owner	Owner	.....	Under city supervision
Rockford	Owner	City	.....	.....
Waukegan	City	City	Actual cost	Under pavements, sand backfill
Winnetka	City	City	Cost	Use all sand under pavements
Indiana				
Bedford	Owner	Owner	.....	.....
Boonville	Owner	Owner	.....	Under city supervision
Decatur	Owner	Owner	.....	.....
Elwood	Owner	Owner	.....	None—very unsatisfactory
Fort Wayne	Owner	City	Sliding scale	Tamp in 6-in. layers
Gary	Owner	Owner or city	Cost	None
Huntington	Owner	Owner	.....	Tamp in layers
Marion	City, if paved	City	Labor and materials	Contractors and plumbers bonded
Martinsville	Owner	Owner	.....	.....
Peru	Owner	Owner	.....	Supervision of city eng'r and street com'r
Portland	Owner	Owner	.....	Supervision city eng'r
Richmond	City	City	Actual cost plus 12%	.....
Seymour	Owner	Owner	.....	Supervision of city eng'r
Shellyville	Owner	Owner	.....	Replace in first class condition
South Bend	Owner	City	Cost	Tamp
Terre Haute	Owner	City	$5 per sq. yd.	Must be flushed
Vincennes	Owner	Owner	.....	Dirt tamped, water added
Wabash	Owner	City	Total cost	Tamp and flush. Cut only between May and Nov., except emergency
Winchester	Owner	.....	.....	.....
Iowa				
Albia	Owner	Owner	.....	Fill with sand under pavements, flush elsewhere
Cedar Rapids	Owner	City	Actual cost	Tamp or flush
Chariton	Owner	Owner	.....	None
Clinton	Owner	City	Cost	Flushed if sandy, tamped if clay
Creston	City	City	Estimated cost of filling and paving	Tamp in 4-in layers; 1:8 cinder concrete in tunnels

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Iowa (Continued)				
Decorah	Owner	Owner	.....	Flush; 12-in. shoulder for concrete base
Eagle Grove	Owner	City	Total cost	Hand tamped or flushed
Emmetsburg	Owner	City	.....	.....
Fort Dodge	Owner	City	.....	Tamp and flush to within 10-in. of subgrade, concrete base 10-in. thick
Glenwood	City	Owner	Cost	.....
Keokuk	City, if paved	City	Exact cost	.....
Muscatine	City, if paved	City	Exact cost	City engineer notified, street commissioner does work
Oskaloosa	Owner	Owner	$5 per sq. yd. of maintenance	Tamp in 9" layers
Ottumwa	Owner	Owner	.....	Tamp in 2" layers, or tamp and flood 24 to 48 hrs. For pavements, 6" or 8" reinf. concr. slab
Sioux City	Owner	City	.....	Tamped under city inspection
Spencer	Owner	Owner	.....	Well tamped and settled
Waterloo	City	City	1½" sheet asph., $6.50; 2", $7; 2" asph. cover, $6.50; brick or wood block, $7; brick on macadam base, $2.50; concrete, $4. Backfilling, $1.25 per cu. yd.	.....
Kansas:				
Atchison	City	City	$3.60 to $6.30	.....
Chanute	Owner	.....	.....	Water tamping where practicable
Columbus	Owner	City	Cost	.....
Fort Scott	City	City	Labor and material	Return all material by tamping
Independence	Owner	Owner	.....	Tamp 6" layers; city furnishes tamping machine
McPherson	Owner	City	.....	None
Paolo	Owner	Owner	.....	Inspected by street department
Salina	Owner	Owner	Actual cost	Satisfactory to city engineer
Wichita	Owner	City	$5 to $7 (kind and age of pavement)	.....
Kentucky:				
Ashland	Owner	City	Actual cost	Must be tamped
Corbin	Owner	Owner	.....	.....
Lexington	Owner	City	.....	Flushing
Ludlow	Owner	Owner	.....	.....
Paducah	City	City	Actual cost	Deposit and indemnity bond
Richmond	Owner	Owner	.....	None
Maine:				
Augusta	Owner	Owner	.....	Either tamp or fill trench with water
Bangor	Owner	City	Gravel, $1; macadam, $2.50; concrete, wood block, brick, $4	Satisfy superintendent of streets
Gardiner	Owner	Owner	.....	Return all material tamped dry
Lewiston	Owner	City	Cost	.....
Portland	Owner	City	Bitulithic, brick, wood blk., $4; all others, $2.50	Tamp 12" layers, sometimes puddled, material dry in freezing weather
Rockland	Owner	City	Actual cost	None
Maryland:				
Hagerstown	Owner	City	Cost plus 10%	.....
Salisbury	Owner	City	Cost	Compact in 12" layers, upper part damp
Massachusetts:				
Athol	Owner	Owner	.....	As good as found
Attleboro	Owner	City	.....	None
Brockton	Owner	City	Actual cost	None
Brookline	Owner	Town	.....	Satisfaction of supt. of streets
Easthampton	Town	Town	Cost plus 5%	Tamp in 6" layers
Fitchburg	Owner	City	Actual cost	.....
Greenfield	Owner or city	Same	Cost including overhead	.....
Hudson	Town or Gas Co.	Town	Cost	None
Lowell	Owner	Owner; city stone block	.....	.....
New Bedford	Owner	Gas & Tel. Cos., others by city	.....	None
North Adams	Owner	City	Actual cost	Well tamped
Peabody	Owner	City	Total cost	Ram and puddle
Pittsfield	Owner	City	Actual cost	None
Rockland	Town	Town	Cost	None
Waltham	Owner	City	Cost	None
Webster	Owner	City	None	None
Worcester	Owner	City	Total cost	Leave in as good condition as found
Michigan:				
Ann Arbor	Owner	City	Cost	Tamp
Benton Harbor	Owner	City	Actual cost	None
Cadillac	Owner	.....	.....	Water and tamp
Detroit	Pub. utilities; city for others	City	Cost of labor, materials and inspection	Well tamped. Selected material if original material not satisfactory
Dowagiac	Owner	City	Cost	Replace all dirt
Grand Rapids	Owner	City	Cost plus 10%	Thoroughly tamp and flush
Hastings	City	City	.....	.....
Holland	Owner	City	Cost	Now under preparation
Houghton	City	City	.....	.....
Iron Mountain	City	City	Actual cost	Puddle all trenches
Ironwood	Owner	City	Cost	Tamp in 6" layers or puddle
Kalamazoo	City	City	Cost	.....
Mt. Clemens	Owner	Owner	$1 for inspection	Hand tamp and puddle; stand two weeks before repaving
Muskegon	City	City	Cost	Tamp in 6" layers and puddle
Muskegon H'ghts.	Owner	.....	.....	None
Negaunee	City	City	Actual cost	Hand tamp and flush
Niles	Owner	Owner	.....	.....
Owosso	City	Owner	Cost plus 10%	Tamp under pavements
Pontiac	Owner	City	.....	Tamp and flush, city inspection
Port Huron	Owner	City	.....	.....
Saginaw	City	City	.....	Puddle, flush periodically for 1 year. If to be paved earlier, use 1 sand to 1 clay
Sault Ste. Marie	Owner	City	Actual cost	City inspection

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Michigan (Continued)				
Sturgis	City	City	Total cost plus 25%	Under pavements, flush and hand tamp
Minnesota:				
Albert Lea.....	Owner	City	Actual cost	Ordinances
Austin	Owner	City	$50	Flush and tamp
Brainerd	Owner	City and owner	Actual cost	Careful and safe manner
Duluth	City	City	Total cost	Use sand or gravel only
Ely	Owner	.....	.....	None
Faribault	Owner	Owner	Cost	Replace original condition. Plumber's bond
Little Falls.....	Owner	City	Cost	Sandy soil. Puddle
Mankato	Owner	City	Cost	Bond and city supervision
Minneapolis	Owner	City	.....	Inspection by city engineer
New Ulm.....	Owner	City	Total cost	None. Sand and gravel soil
Rochester	Owner	Owner	.....	Tamp and flush. Sand refill under pavements
St. Cloud.....	Owner	City	Cost plus 10%	Water and tamp in 6" layers
So. St. Paul.....	Owner	Owner	Cost of inspection	Wet well and tamp in 6" layers
Willmar	Owner	Owner	.....	Flush
Winona	Owner	City	$3 with concrete base, $1.50 if no base, $2 for macadam	Water and tamp
Mississippi:				
McComb	City	City	Actual cost	.....
Missouri:				
Boonville	City	Owner	.....	None
Brookfield	Owner	Owner	.....	Under pavements, refill with sand
Cape Girardeau...	Owner	City	Actual cost	Tamp or flood
Excelsior Springs.	Owner	Owner	.....	Bond to keep in repair
Fulton	City	City	Actual cost	.....
Hannibal	Owner	Owner	.....	City engineer's inspector
Joplin	Owner	City	Actual cost	Tamp and settle thoroughly before paving
Kansas City	Owner	City	Concrete, $3.75; w'd. block, $8; asph., $6; brick & stone block, $5.50; macadam, $3	Tamp and flush
Kirksville	Owner	.....	.....	.....
Maplewood	Owner	City	$10 for 10 sq. ft.	None
Marshall	Owner	Owner	.....	Hand tamp and flood; eng'r directs
Monett	City	City	Force account	None
St. Joseph.....	Owner	City	.....	City will backfill and use sand
St. Louis.....	Owner	City	Cost	Properly tamp in layers
Sedalia	City	City	Exact cost	Tamp in 4" layers. Cut back old pavement 4"
Montana:				
Anaconda	Owner	City	Actual cost	Flush and hand tamp
Billings	Owner	Owner	Exact cost	Engineer's directions. Surety bond
Bozeman	Owner	Paving Co.	Paving Co.'s bill	Flush or tamp in layers
Butte	Owner	City	$35 to $10 per sq. yd.	Tamp 9" layers, 40-lb. tamper; or puddle
Helena	Owner	City	$5 per sq. yd.	Tamp in 3" layers
Kalispell	Owner	City	Cost	Licensed plumber maintains for 1 yr.
Lewistown	City	City	.....	Water settle and tamp
Livingston	Owner	Owner	.....	Under city engineer's supervision
Nebraska:				
Chadron	Owner	City	Cost plus 10%	Tamp dry
Columbus	Owner	City	Actual cost	Tamp in 9" layer. Fill with sand under pavements
Fremont	City	City	Actual cost	Tamp or flood; replace all earth
Grand Island.....	Owner	City	Cost	Puddle
Hastings	Owner	City	Cost plus 20%	Fill 1½ ft., fill trench with water and backfill rest
Lincoln	City	City	Cost plus 10%	Permit $10 for 1 yr. after paving, $5 2d yr., $3 3d to 5th, $1 thereafter
Norfolk	City	City	$2 per cu. yd. for fill, $5 per sq. yd. for paving	Must fill by hand
North Platte.....	Owner	Owner	.....	Return all dirt, tamp and puddle
Omaha	Owner	City	.....	.....
Scottsbluff	Owner	Contractor	.....	None
New Hampshire:				
Berlin	Owner	Owner	.....	.....
Laconia	Owner	City	$2.50 per sq. yd.	.....
Nashua	Owner	City	Cost	Satisfaction of city
Portsmouth	City	City	Cost plus $5	.....
New Jersey:				
Bergenfield	Owner	Owner	.....	Replace in original condition
Bridgeton	Owner	Owner	.....	Saturate well and tamp
Camden	Owner	City	$4 per sq. yd.	.....
Cape May.....	Owner	Owner	.....	.....
Clifton	Owner	.....	.....	Inspected by street department
Edgewater	Owner	Owner	Cost	Ram and puddle
Freehold	Owner	Owner	.....	.....
Millville	Owner	Owner	In paved streets charge per sq. yd. as damages	Satisfaction of city
Newark	Owner	Pub. Serv. Co. blk. pavements, city all others	.....	None
New Brunswick..	Owner	City	Cost	Thorough tamping
Phillipsburg	Owner	Town	Brick $3.60, macadam $0.90, dirt $0.45	None
Plainfield	Owner	City	Depends on type	None
Roselle Park.....	Owner	Borough	Water and gas co.'s cost; others flat rates per sq. yd.	None
Rahway	Owner	City	Cost	Tamp in 6' layers satisfactory to engineer
Rutherford	Owner	Borough	Av. $11 per opening	Tamp in 6" to 12" layers, puddle if required
Salem	Owner	City	Cost	Puddle and tamp
So. Orange.....	Owner	Owner	.....	None
Summit	Owner	Owner or city	Actual cost	Supervision of city engineer
Trenton	Owner	Owner or city	.....	.....
Wallington	Owner	Owner	.....	.....
New Mexico:				
Albuquerque	Owner	City	.....	Water-tamp
Roswell	Owner	City	Cost	.....
Santa Fe.....	Owner	Owner	.....	None

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
New York:				
Amsterdam	Owner	City	Actual cost	.....
Auburn	Owner	Owner or city	Cost	Replace in original condition
Binghamton	Owner	Owner	.....	Replace in as near former condition as possible
Buffalo	Owner	City, by contract	.....	Tamp in 6" layers if clay. Temporary pavement in winter
Cohoes	Owner	Owner	.....	None
Corning	City	City	Cost of fill	Tamping machine used
Cortland	Owner	City	Actual cost	Tamp in 6" layers
Endicott	Owner	Owner	.....	None
Fulton	City	City	Cost	None
Geneva	Owner	City	Actual cost	Tamp dry, one shoveler to 2 tampers
Glens Falls	Owner or city	City	Actual cost	None, unfortunately
Gloversville	Owner	City	Actual cost	None
Herkimer	Owner	City	Total cost	Tamp in 6" layers, wet if necessary
Ithaca	Owner	Owner	.....	Two tampers to 1 shoveler
Jamestown	Owner	City	Actual cost	Wet down and thoroughly tamp
Johnson City	Owner	Owner	.....	Puddle and tamp
Kingston	Owner	City	Cost	Puddle, take care of till settled
Lackawanna	Owner	Owner	.....	Wet and tamp in 12" layers
Lancaster	Owner	Owner	.....	Supervision of street commissioner
Little Falls	Owner	Owner	Cost plus 10%	Any reasonable direction of city
Lockport	Owner	Owner	.....	One tamping to two shoveling. Puddling allowed
Massena	Owner	Village	Actual cost	Puddle and tamp thoroughly
Newburg	City	City	All cost	.....
New York — Manhattan Borough.	Owner	City or Pub. Serv. Corp.	.....	.....
Niagara Falls	Owner	Owner	Cost	Fill with crushed stone if to be paved at once
No. Tonawanda	Owner	Owner	.....	None
Ogdensburg	Owner	Owner	.....	Dry material well tamped
Olean	Owner	Owner	.....	Tamp in 12" layers—sometimes soak afterwards
Oneida	Owner	Owner	.....	None
Port Chester	Owner	Village	Cost plus $5.00	None
Poughkeepsie	Owner	City	Fee for opening and cost of repairing	Direction of city inspector
Rochester	Owner	Owner	.....	Tamp in 6" layers
Schenectady	Owner	Base by owner, top by city	.....	Use water
Watertown	City	City	Cost of sand, trucking and repaving	Backfill with sand
Waverly	Owner	Owner	.....	.....
North Carolina:				
Asheville	Owner	City	.....	.....
Charlotte	Owner	City	.....	None
Durham	Owner	City	Rates per sq. yd. for each type	.....
Greensboro	Owner	City	$8 per sq. yd.	.....
Mount Airy	Owner	City	Actual cost	Inspector's instructions
North Dakota:				
Fargo	Owner	City	Actual cost	Backfill with gravel and plank
Grand Forks	Owner	Owner	.....	Use reinforcing rods over trench
Minot	Owner	City	Cost	Tamp or puddle under city superv'n
Wahpeton	Owner	City	Cost	Backfill with gravel or cinders, leave open until settlement ceases
Ohio:				
Akron	Owner	City	.....	Tamp; puddle in some cases
Alliance	City	City	$1 per lin. ft. for sewer, 25c. per lin. ft. for water	.....
Ashtabula	City if paved, owner otherwise	City	Cost	Flush or tamp
Bellaire	Owner	City	Actual cost	Tamp or flood with water
Bellevue	Owner	Owner	.....	None
Bucyrus	Owner	Owner	.....	Tamp to within 13" of surface, open 1 ft. wider on each side, place 8" of concrete, pave
Cambridge	City	City	.....	.....
Chillicothe	Owner	Owner	.....	Well watered
Cincinnati	Owner	City	Cost	Well tamped, flushed if necessary
Columbus	City or utility co.	Same	.....	.....
Conneaut	Owner	City	Actual cost	Fill 2 ft. over pipe, fill with water, throw in dirt
Dayton	Owner if dirt or gravel, city if paved	City	$1.25 for brick or concrete, $1.50 for asph. or granite. More if more than 2 ft. wide or 7 ft. deep	Must be flushed
Delaware	Owner	City	Actual cost	Settle with water if over 3 ft. deep
East Youngstown	City if paved, owner otherwise	City	Cost plus 5%	Tamp and flush, settle two weeks
Elyria	Owner	City	Actual cost plus 15%	Tamp or flush, city engineer superv'n
Findlay	City	City	Cost	Two tamping to 1 backfilling
Greenville	Owner	Owner	.....	Tamp 12" above structure, fill half full and flood, fill balance in water. Concrete base 12" wider than trench on each side
Ironton	Owner	Owner	.....	Tamp or flush under city direction
Lakewood	Owner	City	Brick $7; asphalt $10	Backfill with sand tamped and flushed
Lancaster	Owner	Owner	.....	.....
Marion	Owner	Owner	Cost	Tamp or flush
Middletown	Owner	City	Concrete and bit mac. $3.60, wood block, brick & asph. $5.40	Flush under inspection
Newark	City	City	Actual cost	None
Niles	Owner	City	Actual cost	Maintain until repaved
Oberlin	Owner	Village	Cost plus 10%	Tamp
Ravenna	Owner	City	.....	Tamp and flush
Salem	City	City	Cost	Tamp or flush
Struthers	City where paved, owner elsewhere	City	Cost plus 5%	Flush and tamp, settle several weeks
Troy	Owner	City	Actual cost	Flush

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
Ohio (Continued)				
Warren	Owner	City	Actual cost	Tamp dry dirt in 6" layers, remove wet dirt
Washington C. H.	Owner	City	.....	.....
Wooster	Owner	Owner	.....	.....
Zanesville	Owner	Owner	.....	Paved streets, thoroughly compact, concrete extend 6" beyond trench
Oklahoma:				
Muskogee	City or owner	City	$10 for pav't, cost for dirt	Both flush and tamp
Norman	Owner	Owner	....	None
Shawnee	City	City	$5 per sq. yd.	Tamp in 6" layers
Tulsa	Owner	Owner	Cost plus 20%	Five-year maintenance under pav'ts
Wagoner	Owner	City	Cost	Flush and tamp
Oregon:				
Astoria	Owner	City	.....	Tamp or flood under instruction
Dallas	Owner	Owner	.....	Water tamp
Eugene	Owner	City	Cost	City direction
Oregon City	Owner	Owner	.....	First class job
Portland	Owner	City	Total cost plus 10%	Use water and tamp well
Salem	Owner	City	Actual cost	Tamp and puddle
Pennsylvania:				
Allentown	Owner	Owner	Cost plus 10%	Two tamping to 1 shoveling; puddling prohibited
Altoona	Owner	City	Actual cost	.....
Bangor	Owner	Owner	$1 plus cost of supervision	Supervision of borough engineer
Berwick	Owner	Borough	Cost plus 20%	Maintain for 30 days
Blairsville	Owner	Owner	Actual cost	None
Bradford	City	City	Entire cost	Tamp in 6" courses
Butler	Owner	City	Cost	As good condition as found
Catasauqua	Owner	Boro, by contract	Cost	.....
Chambersburg	Owner	Borough	Cost	Thoroughly tamp, settle two months
Clairton	Owner	Owner	.....	Tamp, flush, concrete 12" wider than hole reinforced with ½" rods spaced 6"
College Hill	Owner	Owner	Cost	Puddle and tamp; under pavement, top 12" filled with gravel or coarse cinder and 2" of sand
Connellsville	Owner	Owner	Cost	"Carefully"; 6" concrete extend 6" on sides
Dale	Owner	Owner	.....	Ram solid, 6" concrete extend 6" on sides
Duquesne	Owner	Owner	.....	None
Easton	Owner	City	.....	Adequate tamping, solid to street level
Ellwood City	Owner	Borough	Actual cost	Direction of borough engineer
Farrell	Owner	Borough	Entire cost	.....
Franklin	City	City	Cost	.....
Freeland	City if pav., owner otherwise	City	$6 per sq. yd.	.....
Greensburg	City	City	Cost	Thoroughly tamped; 8 in. concrete extends 9 in. beyond trench
Greenville	Owner	City	Cost plus 20%	Flushed in warm weather; dry if cold
Grove City	Owner	Borough	Cost plus 10%	If paved, 6 in. reinforced slab extending 18 in. beyond trench
Hanover	Owner	Borough	$4 per sq. yd. if paved	None
Harrisburg	Owner	City	$3.50 for asphalt	None
Hazleton	Owner	City	Cost	.....
Indiana	Owner	Owner	.....	Good shape as originally—Never is
Jersey Shore	Owner	Borough	.....	Tamp in 4 in. layers
Lebanon	Owner	City	Cost	None
Meadville	Owner	City	.....	Maintain until pavement is laid
Monongahela	City	City	Cost plus $2	Ram thoroly; 6 in. concrete extends 12 in. beyond trench; reinforced if trench more than 3 ft. wide
Munhall	Owner	Owner	.....	None
Nazareth	Owner	Borough	Asph. conc., $2.70; macadam, $1.35; gravel .45	None
New Brighton	Owner	Borough	Cost	Tamp well or wet
Norristown	Owner	Owner	.....	Ram, construct concrete arch extending 6 in. beyond trench, lay 6 in. concrete base on this
North East	Owner	City	Cost	None
Oil City	Owner	City	Cost plus 15%	None
Pittston	Owner	City	$10 per sq. yd.	None
Rankin	Owner	City	Actual cost	None
Reading	Owner	City	Cost	.....
Reynoldsville	Owner	.....	Total cost	Tamp with water
Sayre	Owner	Borough	Cost	.....
Scranton	Owner	City	$3.75 per sq. yd., $4.50 if less than 10 sq. yd.	Tamp in 12-in. layers
Sewickley	Owner	City	Cost plus 10%	New conc. extend 6-in. beyond trench
Sharon	Owner	City	Actual cost	Thoroughly tamp.
Sharpsville	Borough	Borough	.....	.....
Somerset	Borough	Borough	.....	Thoroughly soaked during filling
Throop	Owner	Borough	None	Flush
Tyrone	City	City	Cost	Thoroughly wet and damp.
Waynesboro	Owner	City	Cost	.....
Wilkes-Barre	Owner	City	Asph. $5 per sq. yd., brick $4.50, earth 20c.	.....
Williamsport	Owner	City	$7 per sq. yd.	New conc. extend 6-in. beyond trench
Woodlawn	Owner	Owner	.....	Instructions of street commissioner
York	Owner	Owner	Actual cost plus 10%	.....
Rhode Island:				
Cranston	Owner	City	Macadam $1.50, penetration $3, asphalt $8.15	None
Pawtucket	Owner	City	.....	None
Providence	Owner	Owner or city	Cost	Return street to original condition
Woonsocket	Owner	City	Cost	.....
South Carolina:				
Charleston	City	City	Fill, 40 to 80c per cu. yd.	Tamp in 6-in. layers
Chester	Owner	City	Cost	City engineer's instructions
Florence	Owner	Owner	.....	Replace as before
Greenville	Owner	City	$15 for 1st yd., $10 for each additional	Hand or water tamped

City.	Who Backfills Street Trenches?	Who Replaces Pavement Over Trenches?	What Charge Does City Make?	Special Regulations for Backfilling.
South Carolina (Continued)				
Orangeburg	City	City	Actual cost	Tamp.
South Dakota:				
Mitchell	Owner	City	.....	Tamp in layers, flush, allow to settle
Sioux Falls.....	Owner	City	$3 per sq. yd.	Tamp or flush
Tennessee:				
Alcoa City.....	City	City	Actual cost	Tamp in thin layers
Clarksville	Owner	City	Cost	Tamp.
Cleveland	Owner	City	Actual cost	Water tamp
Dyersburg	Owner	City	.....	Fill by hand
Jackson	Owner	City	Actual cost	Supervision of city engineer
Trenton	Owner	Owner	.....	Replace in original condition
Texas:				
Amarillo	Owner	City	Cost	If paved, fill with gravel
Ballinger	Owner	Owner	.....	None
Bonham	Owner	.....	.....	Lower part puddled, upper tamped
Cleburne	Owner	Owner	.....	Satisfy city engineer
Corpus Christi....	Owner	City	Cost	None
Dallas	.....	City	.....	Tamp and flush under inspection
Denton	Owner	City	None	Supervision of city engineer
Eastland	City	City	Cost	Puddle or fill with sand or gravel
Mexia	Owner	City	.....	Flush and tamp
Mineral Wells.....	City	City	$2 per lin. ft.	.....
Paris	City	City	Actual cost	City does first-class job
San Angelo .....If paved, city; otherwise owner		City	Cost plus 10%	Direction of city engineer
San Benito.....	Owner	Owner	.....	Return all material excavated
Weatherford	Owner	City	$5 per sq. yd.	Dump or use scrapers
Utah:				
Brigham	City	City	None	Wet down and tamp
Logan	Owner	Owner	Actual cost	Tamp and flush
Ogden	Owner	Owner	.....	None
Provo	Owner	Owner	.....	Puddle and ram
Salt Lake.....	Owner	City	$8.55 per sq. yd.	Moisten and tamp in layers
Tooele	Owner	City	None	Tamp in 6-in. layers
Vermont:				
Barre	City	City	.....	Leave surface as good as original
Bennington	City	City	.....	.....
Rutland	City	City	Actual cost	One tamp to 2 shovels, 12-in. layers
Virginia:				
Danville	City	City	Cost	Pav't not opened before 3 years old
Washington:				
Aberdeen	Owner	Owner	Cost	.....
Dayton	City	City	Cost	.....
Mount Vernon....	Owner	City	Cost	Tamp or flush
Puyallup	Owner	City	.....	Tamp by hand around & 1 ft. above pipe
Yakima	Owner	City	$3.50 per sq. yd.	Thoroughly water settle
West Virginia:				
Bluefield	City	City	Actual cost	None
Charleston	Owner	Owner	.....	Replace, good condition as original
Clarksburg	Owner	Owner	.....	None
Fairmont	Owner	City	.....	.....
Wisconsin:				
Delavan	Owner	City	Total cost	Under direct supervision
Eau Claire	City	City	Cost	None
Janesville	Owner or city	Owner or city	Cost	None
Kaukauna	Owner	Owner	.....	Under city inspection
La Crosse	City	City	Cost plus 20%	.....
Manitowoc	Owner	City	.....	Tamp or puddle; 3" mound allowed
Marinette	Owner	Owner	.....	Restore in good condition as found
Menomonie	Owner	Owner	.....	Use water
Norwalk	Owner	Village	.....	None
Ripon	Owner	Owner	Cost plus 10%	Puddle in sand or gravel, tamp elsewhere
Stevens Point.....	City	Contractor	.....	Water tamp—soil is sandy
Tomahawk	Owner	.....	.....	Refill in same condition
Waukeshaw	Owner	City	$20 per opening	Tamp in 9-in. layers
Wausau	Owner or city	Owner	Actual cost	Puddle and tamp
Wisconsin Rapids.	City, if paved, otherwise owner	City	Cost	Leave in as good condition as found
Wyoming:				
Casper	Owner	City	$4 per sq. yd.	Tamp, sprinkle if necessary; refill with gravel where necessary
Sheridan	Owner	City	.....	Either hand tamp or settle with water

(*Continued from page 58*)

Bacterial removals were about what would be expected. The definitely higher removals recorded by the normal process indicate with clearness the sterilizing effect of the nascent oxygen released in the electrolyzer. The evidence to this effect is unmistakable, and the almost total destruction of the delicate Bascillus coli is just what would be expected in this connection.

Regardless of any standards hitherto promulgated, tentatively or otherwise, limiting the amount of dissolved organic matter in a given sewage effluent which safely may be discharged into a stream without creating a nuisance therein, the fact remains that with the normal process the final effluent remained *and without putrefactive odor* for at least three times the period true of the effluents of the excess lime method. In other words, by the methylene blue test the color was discharged in samples of the latter in two and one-half days' incubation at 20 deg. C. as compared with seven days (plus) for the former.

It has been repeatedly demonstrated that sewage clarified with lime will putrefy on mixing with river water, even if fairly sterile when discharged. The same phenomenon was observed during tests at Allentown. Where excess lime treatment reduced the dissolved organic nitrogen from 18 to 10.4 parts per million, this effluent, mixed with four volumes of river water, absorbed 6.5 parts of dissolved oxygen in five days' incubation in an open container at 30 deg. C. This was a representative result. On the other hand, with the normal method of operation, and with eight parts per million of dissolved organic matter in the effluent, this effluent, mixed with four volumes of river water, absorbed two parts per million of dissolved oxygen in five days' incubation in an open container at 30 deg. C. This also was a representative result.

The writer has always believed that the unusual stability of Direct Oxidation process effluents is in a large measure due to the actual wet combustion of perhaps immeasurable quantities of the most putrescible of the organic matters in the sewage. The result of the Allentown tests seem to resolve this supposition into a fact of considerable reliability.

Since this test was made, mechanical improvements have been made in the plant, but no changes in the theory or details of operation.

STONE BLOCK AND BRICK PAVEMENT LAID IN 1922

Name of City.	Stone-Block: Area in sq. yds.	Stone-Block: Cost, total or per sq. yd.	Brick: Area in sq. yds.	Brick: Cost, total or per sq. yd.
Alabama:				
Birmingham	2,646	$13,721.00	15,327	$60,583.00
Connecticut:				
Bridgeport	1,600	6,400.00[c]	.....	.....
New Haven	.....	.....	2,764	6,000[l]
Willimantic	1,900	9,991.00	.....	.....
Delaware:				
Wilmington	17,964[a]	4.16[d]	13,400	4.75[d]
Florida:				
Tallahassee	.....	.....	12,000	2.50
Illinois:				
Chicago	3,171	.....	136,889	.....
Danville	.....	.....	25,000	3.30[b]
Decatur	.....	.....	23,482	98,395.00[k]
DeKalb	.....	.....	7,000	27,000.00[f]
Joliet	.....	.....	17,100	.....
Macomb	.....	.....	14 city blocks	3.40[b]
Marion	.....	.....	1,100	3.96[b]
Mattoon	.....	.....	22,000	3.25[b]
Moline	.....	.....	18,000	Br. flat 2.28[l] Br. edge 2.73
Ottawa	.....	.....	25,000	3.40[b]
Quincy	.....	.....	29,320	113,900.00[d]
Waukegan	.....	.....	1,250	5,900.00[l]
Indiana:				
Bedford	.....	.....	4,200	3.70
Decatur	.....	.....	1,420	4.00
Elwood	.....	.....	1.584[a]	.....
Fort Wayne	.....	.....	8,487	40,737.00[l]
Plymouth	.....	.....	17,000	2.64
South Bend	.....	.....	867	3,169.00[t]
Winchester	.....	.....	2,400	3.50
Iowa:				
Cedar Rapids	.....	.....	26,353	95,743.00[k]
Keokuk	.....	.....	1,584	3.23[c]
Muscatine	.....	.....	25,487	110,210.00[k]
Ottumwa	.....	.....	17,000	3.92
Kansas:				
Atchison	.....	.....	2,000	3.48
Ft. Scott	.....	.....	60,000	2.90[b]
Independence	.....	.....	7,000	2.85[b]
Salina	.....	.....	55,400	215,000.00[b]
Wichita	.....	.....	26,964	128,856.00[k]
Kentucky:				
Ashland	.....	.....	3,800	5.35[b]
Maine:				
Bangor	1,981[a]	3.39[c]	.....	.....
Portland	9,060	.....	2,022	.....
Rockland	.....	.....	1,147	4,197.00
Massachusetts:				
Brockton	224	2.50[c]	.....	.....
Brookline	.....	.....	1,062	4.03
Fitchburg	10,500	4.10	.....	.....
Lowell	22,933	.....	.....	.....
New Bedford	3,973	8.20[c]	.....	.....
Pittsfield	.....	.....	12,343	4.75[c]
Worcester	3,154[a] relaid 2,040 new	5.50[a] 7.50[c]	.....	.....
Oklahoma:				
Muskogee	.....	.....	3,800	$4.20[n] 3.90
Pennsylvania:				
Allentown	.....	.....	1,342	5,766.00[c]
Altoona	.....	.....	37,295	126,450.00[d]
Bradford	.....	.....	29,905	151,000.00[r]
Butler	.....	.....	10,450	2.95[b]
Clairton	.....	.....	9,158	3.50[b]
Ellwood City	.....	.....	2,300	3.37
Farrell	.....	.....	7,638	18,200.00[e]
Franklin	.....	.....	11,544	2.15
Greensburg	.....	.....	2,787	3.04[c]
Greenville	.....	.....	8,500	31,800.00[l]
Grove City	.....	.....	2,000	3.10[b]
Hazelton	.....	.....	912	4,251.00[d]
Jersey Shore	.....	.....	952	3.15[d]
Meadville	.....	.....	20,000	3.42[c]
Monongahela	.....	.....	14,210	60,308.00[d]
North East	.....	.....	8,000	41,403.00
Oil City	.....	.....	8,834	2.47[a]
Parkesburg	.....	.....	666	.....
Scranton	2,005	8.00[c]	.....	.....
Sewickley	.....	.....	5,184	1.28½[v]
Sharon	.....	.....	3,850	17,826.00[f]
Throop	.....	.....	2,500	7.00
Williamsport	.....	.....	1.35 mi.	3.50[c]
York	.....	.....	426	1,920.00
Rhode Island:				
Providence	17,587	5.55[b]	.....	.....
Woonsocket	3,800	$4.20[n]	.....	.....
Texas:				
Amarillo	.....	.....	101,000	410,000.00
Virginia:				
Danville	6,636	6,375.00[c]	.....	.....
West Virginia:				
Charleston	.....	.....	17,321	.....
Clarksburg	.....	.....	19,800	118,800.00[r]
Fairmont	.....	.....	2,880	8,776.00[c]
Wisconsin:				
Wisconsin Rapids	.....	.....	6,500	3.82[b]

[a]—Surface only. [b]—Surface and base. [c]—Surface, base and grading. [d]—Surface, base, grading and curb. [e]—Surface, base, grading, sewer adjustments. [f]—Surface, base, grading, curb, drainage. [g]—Surface, curb and gutter. [h]—Surface, base, grading, curb and gutter. [l]—Entire improvement. [k]—Entire improvement, including engineering, inspection, etc. [l]—Top only; 6" base cost $1.40. [m]—$6.60 for N. Y. speci. on 8" concrete base; $2.65 for old blocks on 8" base (formerly on sand) plus $13 per M. for recutting. [n]—3" brick on 7" base, $4.20; on 6" base, $3.90. [r]—Resurfacing over old pavement. [s]—Relaid. [t]—Surface, base, grading and drainage. [u]—Surface, base, grading, curb, storm sewer and catch-basins. [v]—Repaving on old base.

SHEET ASPHALT AND ASPHALT CONCRETE LAID IN 1922

Name of City	Sheet Asphalt: Area, Sq. Yds.	Sheet Asphalt: Cost	Asphalt Concrete: Area, Sq. Yds.	Asphalt Concrete: Cost
Alabama:				
Birmingham	17,254	$41,127.00	101,707	$225,187.00

Michigan:				
Ann Arbor	.....	.....	3,423	3.79[b]
Benton Harbor	.....	.....	40,000	2.20
Grand Rapids	.....	.....	1.1 mi.	90,000.00[k]
Kalamazoo	.....	.....	6,927	24,977.00[c]
Mt. Clemens	.....	.....	100	4.00[b]
Niles	.....	.....	1,300	6,200.00[b]
Minnesota:				
Mankato	.....	.....	23,827	3.53[b]
Minneapolis	17,617	88,085[c]	35,185	174,140[c]
Mississippi:				
Hattiesburg	.....	.....	25,500	81,600.00[c]
McComb	.....	.....	23,511	3.81[b]
Missouri:				
Kansas City	.....	.....	1.19 mi.	67,200[b]
St. Louis	46,880	252,485.00[d]	71,735	413,939.00[d]
Nebraska:				
Omaha	.....	.....	57,932	218,266.00[c]
New Hampshire:				
Nashua	17,348[s]	.88[s]	.....	.....
New Jersey:				
Camden	1.67 mi.	6.60[m]	.....	.....
		2.65		
Newark	2,770	37,700.00[d]	.....	.....
Plainfield	15,400	73,750.00	.....	.....
Rutherford	.....	.....	100	6.25[c]
Trenton	16,000	.....	2,300	.....
New York:				
Buffalo	4,026	.....	9,051	49,222.00
Cohoes	12,655	5.00[f]	.....	.....
Cortland	.....	.....	1,000	4.00[d]
Endicott	.....	.....	8,000	4.96[c]
Fulton	200	7.50	.....	.....
Jamestown	.....	.....	39,792	.....
Johnson City	.....	.....	5,256	24,010.00
Lackawanna	.....	.....	8,850	47,785.00[f]
New York—Manhattan	45,000	7.20[c]	.....	.....
Niagara Falls	.....	.....	41,310	296,196.00[i]
N. Tonawanda	.....	.....	2,361	12,102.00
Olean	.....	.....	3,560	4.00
Rochester	4,000	4.61[b]	1,500	4.06[b]
North Carolina:				
Durham	.....	.....	6,900	3.86[b]
North Dakota:				
Fargo	.....	.....	590	5.65[b]
Ohio:				
Akron	.....	.....	2.96 mi.	3.41[b]
Alliance	.....	.....	2,700	15,000.00[b]
Ashtabula	.....	.....	21,255	5.60[u]
Belleview	.....	.....	2,159	11,200.00
Bucyrus	.....	.....	11,000	42,000.00[i]
Chillicothe	.....	.....	10,800	23,300.00[c]
Cincinnati	105,130	5.28[s]	1,285	2.65[s]
Columbus	18,000	112,000.00[i]	35,000	182,000.00[i]
Dayton	1,258	6,016.00[c]	36,351	174,020.00[c]
E. Youngstown	.....	.....	8,360	34,680.00[d]
Elyria	.....	.....	2,410	17,305.00[f]
Findlay	.....	.....	12,063	2.30[d]
Ironton	.....	.....	33,000	2.62[b]
Lancaster	.....	.....	20,700	53,471.00[i]
Warren	.....	.....	71,600	427,296.00[i]
Wooster	.....	.....	2,600	2.23[b]
Zanesville	.....	.....	4,406	14,311.00[d]

California:				
Monterey	.....	.....	35,000 ft.	0.33
Oakland	.....	.....	1.082 mi.	95,700.00
Santa Barbara	26,603	2.34	21,756	2.43
Santa Rosa	.....	.....	11,111	1.26
Vallejo	.....	.....	4,300	1.80[o]
Visalia	.....	.....	42,873	139,946.00[d]
Connecticut:				
Bridgeport	12,500[m]	35,000.00	.....	.....
Hartford	2,521	10,261[i]	.....	.....
Middletown	36,279	136,500.00[i]	.....	.....
New Haven	12,877	32,800[d]	5,763	13,600[d]
Delaware:				
Wilmington	89,213	2.96[k]	.....	.....
District of Columbia:				
Washington	24,500	3.16	.....	.....
Illinois:				
Centralia	.....	.....	39,000	.....
Chicago	775,893	.....	.....	.....
Danville	40,000[s]	2.35	.....	.....
Decatur	49,187[m]	135,666.00[b]	.....	.....
DeKalb	.....	.....	18,000	43,000.00[u]
Joliet	.....	.....	74,700[c]	422,000.00[d]
East St. Louis	26,500	100,000.00[b]	.....	.....
	6,800	48,000.00[k]	.....	.....
Moline	.....	.....	60,505	2.60[o]
Oak Park	50,261	364,526.00[r]	.....	.....
Quincy	52,060	214,000.00[k]	.....	.....
Riverside	.....	.....	37,800	90,137.00
Indiana:				
Boonville	26,000	3.42[d]	.....	.....
Fort Wayne	24,189	112,955.00[d]	73,529	272,772.00[d]
Huntington	11,851	32,751.00[k]	.....	.....
	6,210[m]	9,935.00	.....	.....
Peru	4,890	58,882.00[n]	.....	.....
South Bend	3,168	22,601.00[n]	63,755	178,229.00[n]
Terre Haute	12,966	50,100.00[k]	.....	.....
Winchester	.....	.....	8,000	1.69[o]-2.24[d]
Iowa:				
Cedar Rapids	.....	.....	1,934	4,647.00[d]
Fort Dodge	8,100	2.34[g]	35,000	2.69[g]
Oskaloosa	40,000[m]	1.42	.....	.....
Kansas:				
Paola	.....	.....	5,401	19,542.00[d]
Wichita	8,041	23,371.00[d]	7,914	56,106.00[d]
Kentucky				
Lexington	3,900	22,800.00[n]	9,700[p]	28,000.00[n]
	.....	.....	14,500[g]	79,000.00[n]
Massachusetts:				
Brockton	.....	.....	822	2.10[i]
Lowell	8,745	.....	9,464	.....
New Bedford	13,601[h]	1.80	.....	.....
Waltham	.....	.....	20,895	2.70[i]
Worcester	38,020	1.80[s]	.....	.....
Michigan:				
Ann Arbor	22,370	2.51[o]	.....	.....
Detroit	716,180	3,188,418.00[k]	.....	.....
Grand Rapids	1.55 mi.	791,000.00[d]	.....	.....
Holland	19,600	53,325.00[d]	.....	.....
Iron Mountain	.....	.....	11,444[m]	43,560.00[r]
Kalamazoo	73,508	183,903.00[o]	.....	.....
Pontiac	11,150	1.60[h]	26,000	1.10[h]
Saginaw	95,135	3.82[d]	.....	.....
Sturgis	81,000	2.21[o]	.....	.....

SHEET ASPHALT AND ASPHALT CONCRETE LAID IN 1922—Continued

Name of City	Sheet Asphalt Area, Sq. Yds.	Sheet Asphalt Cost	Asphalt Concrete Area, Sq. Yds.	Asphalt Concrete Cost
Minnesota:				
Duluth	34,000	4.07[o]	.....	.....
Minneapolis	.....	.....	164,227	594,605[l]
Missouri:				
Kansas City	3.11 mi.	167,777[o]	.....	.....
Marshall	.....	.....	18,000[m]	1.87
St. Joseph	27,893	.....	24,675	.....
St. Louis	70,210	262,525.00[k]	5,365	24,920.00[k]
Nebraska:				
Chadron	.....	.....	72,000	2.78[o]
Grand Island	15,800	2.54[o]	.....	.....
Lincoln	119,030	2.37[l]	49,443	2.57[l]
North Platte	154,300	498,902.00[d]	.....	.....
Omaha	63,800	139,660.00[l]	403,432	1,051,008.00[l]
Scottsbluff	5,800	.....	.....	.....
New Hampshire:				
Berlin	.....	.....	11,202	2.50
Nashua	.....	.....	18,818	.67[t]
New Jersey:				
Bridgeton	.....	.....	35,000	2.00[o]
Camden	7.85 mi.	3.02[u]	.....	.....
Clifton	45,000	3.00[d]	.....	.....
Newark	131,592	363,526.00[k]	36,076	125,044.00[k]
New Brunswick	45,737	174,546.00[k]	.....	.....
Plainfield	46,240	156,000.00[l]	.....	.....
Trenton	60,000 yd.	.....	.....	.....
Wallington	9,607	29,974.00	.....	.....
New Mexico:				
Albuquerque	.....	.....	80,000	240,000.00
New York:				
Buffalo	183,467	902,161.00[d]	.....	.....
Cortland	.....	.....	38,000	1.20 to 1.55[h]
Fulton	.....	.....	47,000	2.30[o]
Geneva	17,000	118,000.00[o]	.....	.....
New York-Manhattan	196,000	2.80[l]	.....	.....
Niagara Falls	27,283	171,133.00[d]	.....	.....
Rochester	247,340	2.93[o]	.....	.....
	93,245	1.79[h]		
Schenectady	53,537.28	194,214.00[h]	.....	.....
	36,992.24	166,066.00[k]		
North Carolina:				
Ashville	43,133	3.63[o]	.....	.....
	10,000	1.62[h]		
Charlotte	241,023	650,000.00[l]	.....	.....
Durham	38,000	3.27[o]	.....	.....
Greensboro	95,000	1.25 to 1.65[h]	9,000	1.15[h]
North Dakota:				
Fargo	13,400	3.60[o]	.....	.....
Ohio:				
Akron	5.44 mi.	2.97[o]	.....	.....
	0.17 mi.	4.20[h]		
Columbus	200,000	810,000.00[d]	.....	.....
Dayton	17,077	105,510.00[l]	.....	.....
Elyria	14,300	68,145.00[n]	8,320	16,000.00[n]
Findlay	51,944	3.55[v]	25,542	3.40[v]
	62,146	2.35[h]		
Lakewood	25,540	151,312.00[n]	228,057	601,697.00[n]
Marion	8,011	41,200.00[k]	.....	.....
Middletown	99,057	277,396.00[l]	.....	.....
Newark	13,571	47,853.00[d]	.....	.....
Warren	2,470	8,684.00[d]	.....	.....
Washington	4,200	3.15	.....	.....
Wilmington	25,066	77,000.00	.....	.....
Oklahoma:				
Muskogee	9,250 yd.	1.14[h]	.....	.....
Tulsa	.....	.....	55,493	6.50[n]
Oregon:				
Portland	.....	.....	22,827	41.817[d]
Salem	.....	.....	5,676	.....
Pennsylvania:				
Allentown	4,495	14,852.00[l]	.....	.....
Farrell	1,794	6,081.00[o]	.....	.....
Greenville	9,000	1.50[h]	.....	.....
Grove City	15,000	3.10	.....	.....
Harrisburg	56,831	175,000.00[l]	.....	.....
Oil City	23,781	.84[h]	.....	.....
Reading	20,897	67,798.00[l]	.....	.....
Scranton	51,254	3.25[l]	.....	.....
Sharon	New 12,600	57,972.00[k]	.....	.....
	Resurf 7,520	15,435.00[h]		
Throop	5,000 yd.	5.25	.....	.....
Wilkes-Barre	26,853	144,708.00[d]	.....	.....
Williamsport	1.74 mi.	3.25[l]	.....	.....
York	25,699	85,293.00[w]	.....	.....
Rhode Island:				
Cranston	.....	.....	14,200	1.41[h]
Providence	59,949	3.00-3.44[o]	.....	.....
South Carolina:				
Charleston	98,736	.89[h]	.....	.....
Greenville	2,330	4,200.00[h]	18,149	45,373.00[l]
Orangeburg	8,535	2.04	94,380	1.92
Tennessee:				
Cleveland	.....	.....	37,600	122,500.00[d]
Dyersburg	15,000	45,000.00	.....	.....
Murfreesboro	16,000	1.15	.....	.....
Utah:				
Salt Lake	.....	.....	20,000	1.90[o]
Virginia:				
Danville	43,186	58,282.00[h]	39,090	108,034.00[l]
Washington:				
Yakima	.....	.....	42,373	97,794.00[n]
West Virginia:				
Bluefield	45,000	180,000.00[k]	.....	.....
Charleston	22,641	.....	120,317	.....
Wisconsin:				
Stevens Point	.....	.....	20,000	2.66[h]

[a]—2-inch native sheet asphalt top, 1-inch close binder, resurface over brick. [b]—Wearing surface, excav., curb, catch basins, drainage, overhead. [c]—Includes 17,000 sq. yd. vertical fibre 3-inch and hillside brick. [d]—Entire improvement. [e]—$1.20 sq. yd. 5-inch base; 40c 1-inch binder; $1.00 1½-inch top. [f]—Includes wearing surface, base, grade, sewer adjustments. [g]—2-inch wearing surface on 5-inch concrete; curb, 6x20 inch 89c per ft. [h]—Top only. [k]—Surface, binder, base, curb, grading. [l]—Wearing surface, base and grading. [m]—Surface, base, grading, curb, drainage. [o]—Surface and base. [p]—Macadam base. [q]—Concrete base. [r]—Surface, curb and gutter. [s]—Laid on old macadam. [t]—Surface, grading, and catch basins. [u]—Surface, base, grading, curb and catch basins. [v]—Surface, base and curb. [w]—Surface, base and gutters.